

COOPERATIVE RABIES MANAGEMENT PROGRAM NATIONAL REPORT 2003



**United States Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services**

COOPERATIVE RABIES MANAGEMENT PROGRAM NATIONAL REPORT 2003

COMPILED and EDITED BY:
Craig D. Kostrzewski
Rabies Program Assistant

REVIEWED BY:
Dennis Slate
National Rabies Program Coordinator

USDA-APHIS-Wildlife Services
59 Chenell Drive, Suite 7
Concord, NH 03301

TABLE OF CONTENTS

EXECUTIVE SUMMARY	4
COOPERATIVE RABIES MANAGEMENT PROGRAM	
ALABAMA	10
ARIZONA	13
CALIFORNIA	18
FLORIDA.....	20
GEORGIA.....	23
KANSAS.....	25
KENTUCKY	27
LOUISIANA	29
MAINE	31
MARYLAND	34
MASSACHUSETTS.....	37
MISSISSIPPI	41
NEW HAMPSHIRE.....	43
NEW JERSEY	46
NEW YORK.....	48
OHIO	53
PENNSYLVANIA	58
TENNESSEE.....	63
TEXAS.....	67
VERMONT	70
VIRGINIA.....	74
WEST VIRGINIA	78
WYOMING	82
NATIONAL WILDLIFE RESEARCH CENTER.....	84

EXECUTIVE SUMMARY

In 2003, United States Department of Agriculture (USDA), Animal Plant and Health Inspection Service, Wildlife Services (WS) participated in coordinated oral rabies vaccination (ORV) projects targeting raccoon (*Procyon lotor*) rabies in 15 eastern States (Figure 1). This included implementation of ORV plans for the first time in Georgia, Alabama, and southeastern Tennessee (GAT) where these states' borders converge. This action was taken in response to increasing levels of rabies activity along the western edge of the current distribution of raccoon rabies in that area. In addition, ORV was conducted in eastern Maine for the first time to complement efforts in neighboring New Brunswick, Canada. Wildlife Services continued its cooperation in ORV projects targeting rabies in coyotes (*Canis latrans*) and gray foxes (*Urocyon cinereoargenteus*) in Texas (Figure 1).

In 2002, WS and cooperators extended the Appalachian Ridge ORV treatment zone, as planned, from southern West Virginia to northeast Tennessee. This ORV zone extends from Lake Erie, in Ohio and Pennsylvania, south through West Virginia and Western Virginia, to northeastern Tennessee, where it articulates with the high mountainous habitats which generally do not support high density raccoon populations (Figure 2). In 2003, this ORV zone was replicated to bolster the immunity in raccoon populations. Also in 2003, this ORV zone was extended approximately 32 km (approximately 20 mi) eastward, in western Pennsylvania, to begin to examine strategies for the reduction of rabies cases in enzootic areas. The ability to create rabies-free zones, within raccoon rabies enzootic areas, is a requisite to achieve elimination of this variant of the rabies virus. In 2003, the Appalachian Ridge ORV zone covered approximately 65,850 km² (26,500 mi²) and was treated with approximately 4.85 million vaccine-laden baits.

Enhanced rabies surveillance continues to be emphasized in Georgia, Alabama, and Tennessee to complement traditional public health surveillance (Figure 3). This complementary information is critical in delineating the leading, western edge of raccoon rabies such that sound ORV decisions can be made to maximize the effective use of resources. Public health surveillance provides for timely testing of suspect animals that had contact with people or their mammalian pets, but does not usually include testing of suspect animals that did not have contact with people or their pets. While extremely effective in protecting the public from rabies, this type of surveillance is less sensitive than required to refine ORV baiting plans. In 2003, WS and cooperators began to emphasize enhanced rabies surveillance as an integral component of ORV in all geographic areas (Figure 2). The protocol includes, in decreasing order of priority, collection and testing of suspect animals (i.e., animals exhibiting aberrant behavior suggestive of rabies) that did not result in a potential or actual human or pet exposure, road kill surveys, and focal removal and testing of individual animals at locations where rabies has been confirmed. Density indexing also is used to characterize raccoon populations where information is lacking and to provide samples from under represented rural areas.

The Centers for Disease Control and Prevention (CDC), Rabies Section, plays a pivotal role in enhanced rabies surveillance through training WS field biologists and technicians in sample collection and submission, timely laboratory diagnosis of enhanced rabies surveillance samples, serological analysis, and expertise on rabies. The Wadsworth Center, New York State Rabies Laboratory and Virginia Division of Consolidated Laboratory Services (Rabies Laboratory) also provides rabies diagnostic support for enhanced rabies surveillance efforts.

In the Northeast, WS continued to work closely with Cornell University and cooperating state agencies in ORV along the Quebec, Canada border from the Connecticut River Valley, in northern New Hampshire/northeastern Vermont, through the St. Lawrence Valley in northern New York. Part of this effort includes cooperation with the New York State Health Department led project in the upper Lake Champlain Valley in New York State. Wildlife Services also participated in ORV activities led by Cornell University on the Niagara Frontier and in Chautauqua County, New York, which link vaccination zones along the south shore of Lake Erie from New York to Ohio (Figure 2). These projects required close field coordination with our Canadian counterparts in Ontario and Quebec. Collectively, this ORV area comprises 28,200 km² (approximately 11,300 mi²) and was treated with approximately 1.75 million baits in 2003. The landscape is interspersed with mountain habitats, large lakes, and rivers.

As a result of funds provided to Cornell University by the Canadian Food Inspection Agency and funding provided by WS to include a study control bait zone, ORV was implemented for the first time in Maine 2003. The ORV zone was designed to create an immune buffer to try to prevent raccoon rabies from spreading north through the St. Croix River Valley and to complement contingency rabies control efforts conducted in neighboring New Brunswick, Canada.

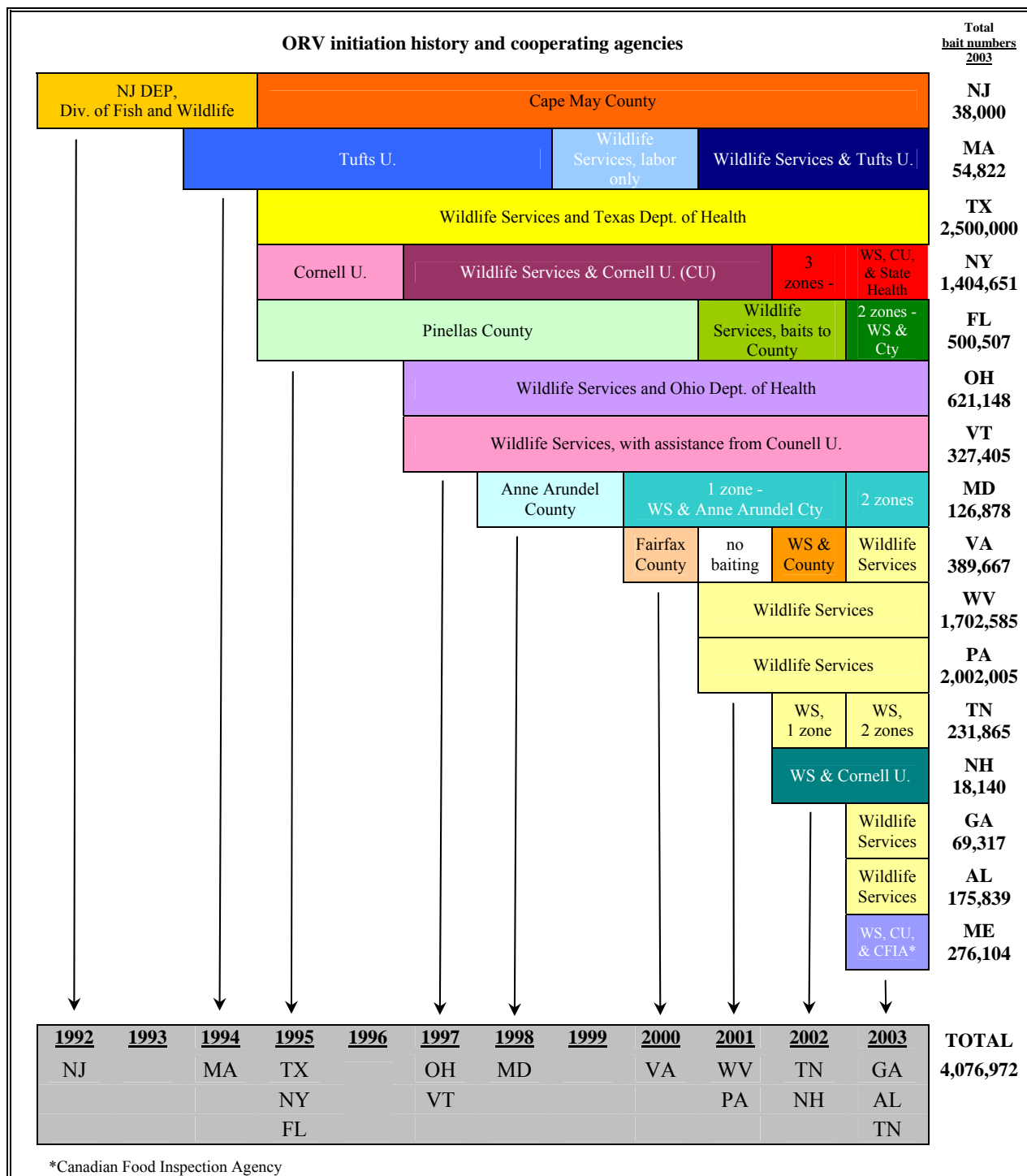


Figure 1. Cooperative Rabies Management Program ORV initiation history, cooperating agencies, and number of baits distributed in the United States, 2003.

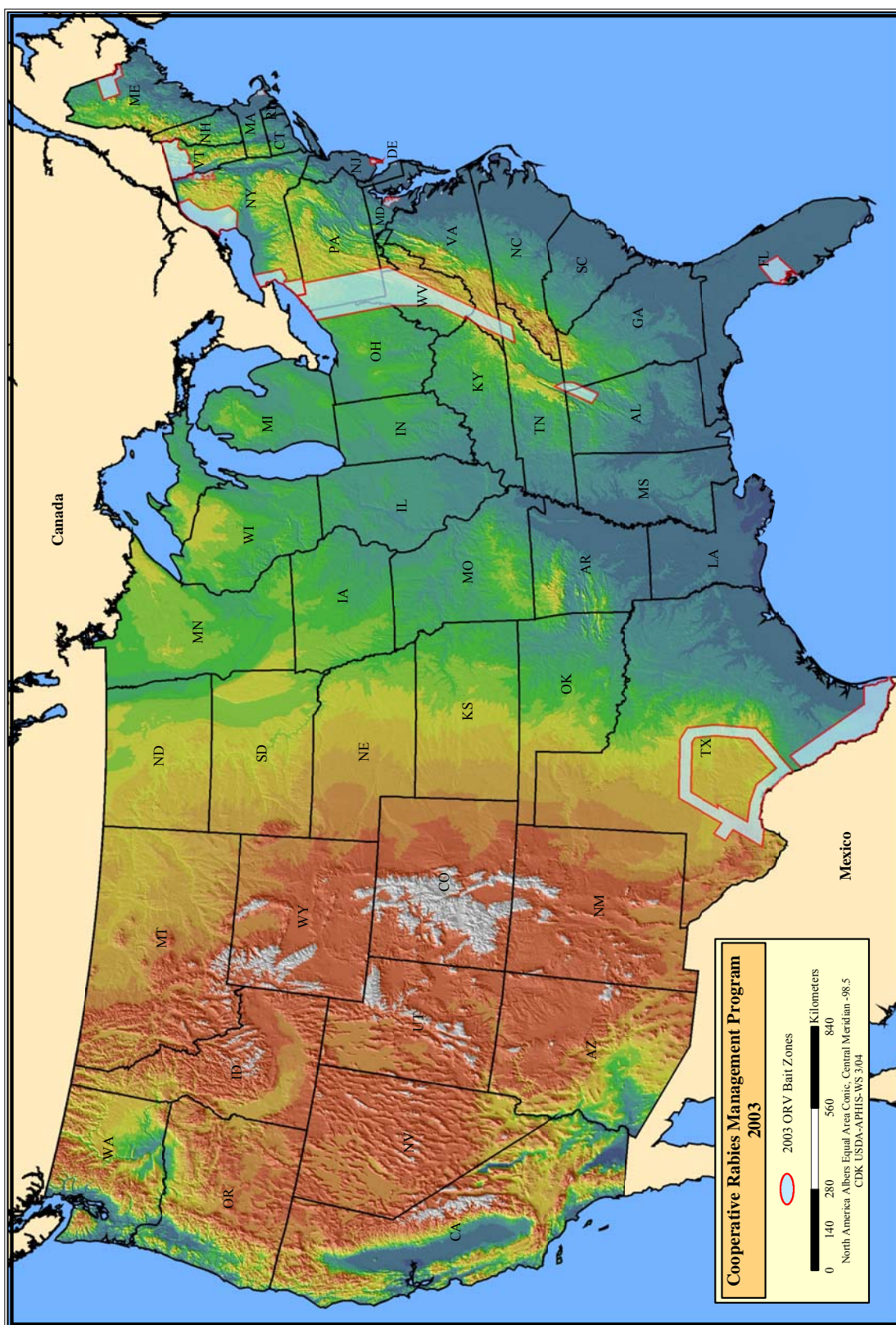




Figure 3. Counties and results of enhanced rabies surveillance conducted in the United States, 2003.

An important component of ORV in the Northeastern United States is a study conducted by Cornell University comparing the performance of the coated sachet (CS) to fishmeal polymer (FMP) baits for delivering oral rabies vaccine in the wild (Figure 4). Results from this study, along with those from captive studies, are critical to decisions regarding the best available bait for delivering oral rabies vaccine to raccoons. Preliminary results, yet to be published by Cornell, suggest that the CS performs at least as good as FMP and often exceeds its performance. Generally higher performance at a lower cost (approximately <20% than FMP), plus the lower risk of damage from aerial bait distribution, make the CS a good interim bait option while other baits are evaluated for safety and efficacy.

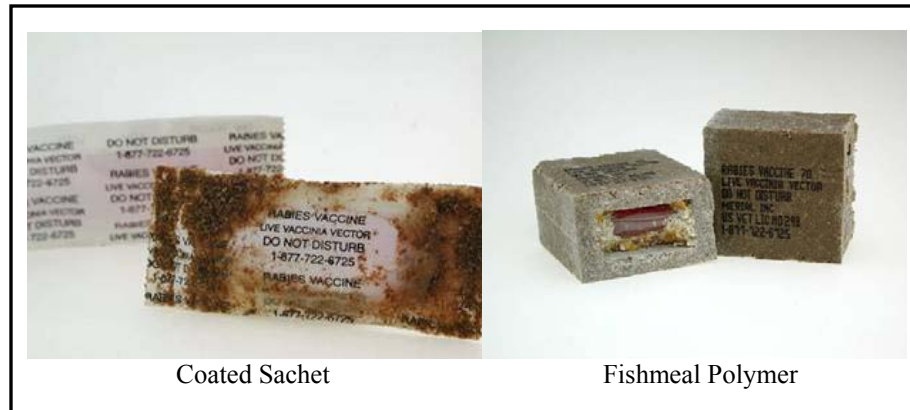


Figure 4. Coated sachet and FMP baits utilized during the National Rabies Management ORV program, 2003. (Photos used with permission from MERIAL Limited, Athens, Georgia, USA).

Wildlife Services participated in cooperative ORV projects in Massachusetts, Maryland, and Florida. While not immediately tied to the larger interstate ORV efforts, these continuing projects have a history which provides valuable information on ORV and surveillance strategies. The Massachusetts project represents an experimental program to try to prevent raccoon rabies from becoming established on Cape Cod, a heavily used resort area, especially during the summer. The Maryland project is designed to investigate if ORV can be used to eliminate raccoon rabies from peninsulas on Chesapeake Bay. The Florida ORV project is an extension of the Pinellas County project, with goals to determine if rabies-free areas can be created in Florida, where raccoon rabies was first described in 1947.

Wildlife Services continues to assume an important cooperative role with the Texas Department of Health and several other agencies and organizations in ORV efforts that began in Texas in 1995. Since 2000, this program has consisted of maintaining a 40-mile wide barrier in south Texas along the Rio Grande River to prevent the canine strain of rabies from re-emerging from Mexico. A single case of canine strain was confirmed within the southern portion of the vaccination zone near Laredo in 2001, underscoring the importance of continuing this preventative ORV management measure and the need for improved long-term surveillance along the border with Mexico. No cases were reported within the barrier during 2002 and 2003. Since its establishment in 2000, the maintenance barrier has been treated with 700,000 vaccine-laden baits (30,080 km² [11,000 mi²]) and covered the same area along the Mexican border (Figure 2).

Wildlife Services is an important funding and operational partner with the Texas Department of Health in ORV efforts to contain a unique gray fox variant of the rabies virus in west-central Texas. In 2003, WS contributed 1.3 million baits and assisted with the distribution of 1.9 million baits over approximately 55,167 km² (21,000 mi²) to contain gray fox rabies control in Texas (Figure 2). Wildlife Services also fills a critical cooperative niche by providing expertise, infrastructure, and equipment to help obtain samples to continue to monitor and evaluate the status of the ORV targeting gray fox rabies, as well as ORV targeting coyotes in south Texas.

Research projects on oral rabies vaccine bait acceptance in free-ranging and captive skunks were initiated, with an emphasis on determining which of the existing bait configurations could best deliver vaccine to skunks. Studies will continue with an emphasis on evaluating CS acceptance by raccoons of various age cohorts. A study on the ecology and movement of raccoons continued in Pennsylvania and studies on urban skunks began in Texas. Bait uptake also was studied in Ohio in a cooperative agreement between WS, National Wildlife Research Center (NWRC) and Ohio State University. Results of these studies will be integral to refining ORV strategies. Research also was conducted on tetracycline biomarker degradation. Results indicate that a combination of initial impurities, bating manufacturing processes, and polymer binding reduce available tetracycline in end-product FMP baits by about 50%. Work is about to begin on *Vaccinia* infection in mice (*Peromyscus* spp.) and other species as a follow-up to previous biosafety studies. Research was funded at Thomas Jefferson University on the development of canine adenovirus as a vector for the rabies glycoprotein gene. Genomic characterization of rabies virus from skunks that died of raccoon variant of rabies in Massachusetts was funded at Tufts University. The impetus for this study centers on the indication that skunks “help” maintain raccoon variant of the rabies virus in the wild. Modeling studies were also funded at Queens and Emory Universities to provide context for better characterizing risks associated raccoon rabies with and in the absence of ORV intervention. Economic studies of direct and indirect

patient post exposure treatment costs for rabies exposures were completed and a benefit:cost analysis was initiated for potential ORV scenarios targeting skunk rabies in California.

The 10 focus teams from WS Rabies Management Team continue to serve as a critical interdisciplinary decision recommending body. The 10 teams discuss and provide recommendations on critical issues such as surveillance, National Environmental Protection Act (NEPA) compliance, vaccine development, baiting strategies, rabies economics, air support for baiting, ORV evaluation, communications planning, contingency action planning, and research prioritization. This interagency coalition of interdisciplinary expertise is vital to achieving national rabies control goals.

In 2004, WS and cooperators will continue to focus on implementing adequate enhanced rabies surveillance and target species monitoring to facilitate sound ORV decisions. We will continue to look for optimal ORV baiting strategies and remain focused on key, applied research that should lead to products to complement current technology. Contingency action planning processes will continue to be evaluated and applied to rabies exigencies where needed. The National Rabies Management Team will continue to provide the interdisciplinary expertise required to optimize ORV to meet national rabies management goals.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM ALABAMA 2003

BACKGROUND

Raccoon (*Procyon lotor*) rabies is thought to have entered Alabama in the late 1970's from Florida. The raccoon variant of rabies has since been detected in most counties east and south of the Alabama-Coosa River system, with a few confirmed raccoon rabies breaches of the Alabama River in Mobile, Clarke, Dallas, Perry, and Autauga Counties. Since 1970, an annual average of 44 raccoons have been confirmed positive with rabies in southeast Alabama, and an average of 8,500 animal bites were investigated annually in the past 10 years by county health department personnel. In 2001, the Alabama Department of Public Health (ADPH) asked Wildlife Services (WS) and other cooperators to help determine the leading edge of the raccoon rabies variant in the state in hopes of developing an effective oral rabies vaccination (ORV) program.

Wildlife Services began enhanced surveillance of road-killed and trapped raccoons in late 2001, in counties west of and bordering the Alabama and Coosa Rivers. Results from 2001-2003 WS surveillance revealed evidence of raccoon rabies west of the river in at least 7 counties: Cherokee, Dallas, Hale, Sumter (2002), Autauga (2002 and 2003), and Marengo and DeKalb (2003). In addition, the ADPH confirmed raccoon rabies infection in a skunk (species not identified), two foxes, and a horse (*Equus caballus*) in Cherokee and DeKalb Counties late in 2002 and early 2003. As a result, in November 2003, the ADPH and the Alabama Department of Agriculture and Industries (ADAI) cooperated with Alabama WS and WS offices in Georgia and Tennessee to initiate Alabama's first-ever ORV effort in 5 northeast Alabama counties (Figure 1). The resulting ORV program was coined the Georgia, Alabama, and Tennessee (GAT) program. The goal of the program was to extend the rabies-immune barrier into parts of Georgia, Alabama, and Tennessee, where raccoon rabies appeared to be moving westward.

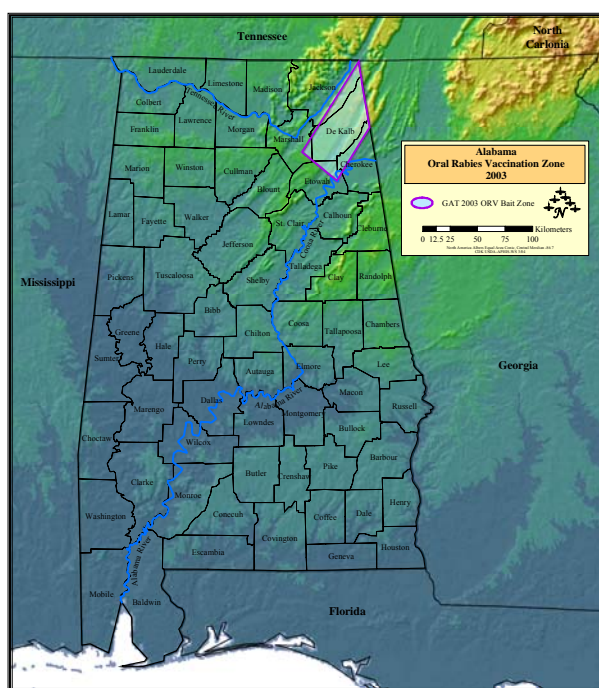


Figure 1. Oral rabies vaccination zone in Alabama, 2003.

ORV PROGRAM 2003

Bait Distribution

The objective of the first Alabama ORV effort was to halt the westward movement of raccoon rabies from northwest Georgia, into Cherokee and DeKalb Counties in Alabama, both of which had confirmed cases in 2002 and 2003 and which had previously been raccoon rabies-free. Wildlife Services personnel and volunteers from the

Centers for Disease Control and Prevention (CDC) distributed baits in Alabama from 14-21 November 2003, in an area that was 3,214 km² (1,241 mi²) (Figure 1). Fishmeal polymer baits containing Raboral V-RG® vaccine (Merial Limited, Athens, Georgia, USA), were distributed from the air and by hand (118,979 and 56,860, respectively) in parts of DeKalb, Marshall, Cherokee, Etowah, and Jackson Counties. The ADPH coordinated information outreach to county and local authorities and assisted WS, Legislative and Public Affairs personnel with media and public inquiries.

Surveillance

In 2003, WS continued to conduct enhanced surveillance targeting abnormally-behaving and road-killed raccoons from counties west of the Alabama and Coosa Rivers. The goal of this surveillance was to determine the leading edge of the raccoon-rabies variant in Alabama. Animal control personnel, county health department environmentalists, and wildlife law enforcement officers contributed animals to this effort as well. Results from enhanced surveillance yielded 2 (0.7%) confirmed cases of rabies using direct fluorescent antibody (DFA) testing and 1 (0.3%) raccoon with a positive rabies antibody response (Table 1).

Table 1. Raccoons (unless otherwise noted) collected for rabies testing by WS personnel, by county, along the Alabama-Coosa River system and westward in Alabama, 2003.

County	Total tested	DFA positive	Positive rabies antibody response ^a
Autauga	9	1	0
Bibb	2	0	0
Blount	3	0	0
Calhoun	1	1 ^b	0
Cherokee	8 ^c	0	0
Chilton	14	0	0
Choctaw	2	0	0
Clarke	43 ^d	0	0
Dallas	45	0	0
Dekalb	20 ^e	0	0
Elmore	7	0	0
Etowah	14	0	0
Hale	14	0	0
Houston	1	0	0
Jackson	12	0	0
Jefferson	28	0	0
Marengo	1	0	1
Marshall	1	0	0
Mobile	2	0	0
Perry	7	0	0
Shelby	31	0	0
St Clair	4	0	0
Sumter	3	0	0
Tuscaloosa	14	0	0
Walker	2	0	0
Total	288	2 (0.7%)	1 (0.3%)

^aCDC serum dilution ≥ 5 ; ^braccoon located east of Coosa River;

^cincluded 1 gray fox (*Urocyon cinereoargenteus*); ^dincluded 1 gray fox;

^eincluded 3 striped skunks (*Mephitis mephitis*)

Population Monitoring

Four studies to index relative densities of raccoon populations were conducted in September and October, 2003, prior to the November bait drop (Table 2). Two were conducted within the proposed bait zone (DeKalb and Cherokee Counties) to index raccoon density in agricultural and forested habitats that dominated the bait drop zone and to determine base-line levels of rabies exposure in raccoon populations within the area. Two additional studies were conducted in forested habitats in southwest Alabama. Studies were conducted using an established protocol of 50 cage traps over 10 consecutive nights (500 trap nights) on a 3 km² study site comprised of a particular major habitat type. Animals were trapped, immobilized, and released after blood and tooth samples were obtained. All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Table 2. Results from relative density (raccoon/km²) studies on 4 sites in Alabama, Fall 2003.

	Little River Canyon National Preserve	Collinsville	Choctaw NWR	Scotch WMA
County	Dekalb/Cherokee	Dekalb	Choctaw	Clarke
Macro habitat	Forested	Agriculture	Forested	Forested
Elevation (meters)	370-450	220-240	10-12	75-120
Index of relative raccoon density	3.7	9.4	13.7	6.0

Post-bait Evaluation

Serum and tooth samples from 130 raccoons captured in the bait drop zone (DeKalb County) were collected 6-8 weeks following the November 2003 bait drop. Animals were trapped using cage traps, immobilized, samples collected, and released. Results from virus neutralizing antibody testing and tooth tetracycline biomarker analysis will be used to evaluate the impacts of Alabama's first ORV baiting effort.

Sex and age ratios for all raccoons sampled (already dead, euthanized, and trapped/released; n= 464) in 2003 were: 273 (58.8%) males, 191 (41.1%) females, 362 (78.0%) adults, and 112 (24.1%) juveniles.

Non-target Captures

Non-target animals captured and released included: 3 Eastern cottontail rabbits (*Sylvilagus floridanus*), 20 opossums (*Didelphis virginiana*), and 15 domestic cats (*Felis catus*). Non-target animals that were captured and euthanized included: 2 gray foxes, 3 striped skunks, and 7 opossums.

SUMMARY

Fall 2003 marked the third year of WS cooperative participation in the Alabama ORV program and the first year ORV baits were distributed in the state. Work emphasized surveillance for evidence of raccoon strain rabies west and north of the Alabama and Coosa Rivers as well as pre- and post-bait ORV drop surveillance. In addition, 4 relative density studies were conducted. Results from 2003 sampling revealed several breaches of the historic "barrier" of raccoon rabies in both northeast and central Alabama. Oral rabies vaccination efforts were initiated in northeast Alabama in an attempt to stop the westward movement of the raccoon strain of rabies from northwest Georgia. Future ORV baiting strategies in Alabama will continue to be directed towards halting the spread of raccoon rabies into West Alabama and beyond. This barrier will be tied to a national planning effort to contain the disease and explore strategies to eliminate the raccoon strain of rabies from North America.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM ARIZONA 2003

BACKGROUND

In Arizona, terrestrial rabies strains occur in the striped skunk (*Mephitis mephitis*) and gray fox (*Urocyon cinereoargenteus*). The skunk strain typically occurs in the southeastern counties of Arizona and the gray fox strain typically runs through the eastern counties, across and up into the central part of the state, below the Mogollon Rim. In addition to the terrestrial strains, a bat (Order *Chiroptera*) strain of rabies also occurs throughout the state.

In 2003, the Arizona Department of Health Services confirmed 75 cases of rabies, a 52% decrease from 2002, when 143 animals were confirmed with rabies, the highest ever on record in Arizona (E. Lawaczeck, Arizona Department of Health Services, personal communication).

In 2003, 2,114 animals involving 26 species were tested for rabies. The 3 main species of animals confirmed with rabies were: bats (44), gray foxes (18), and striped skunks (8) (Table 1).

Table 1. Confirmed rabid animals in Arizona, by county and species, 2003 (Lawaczeck 2004).

County	Skunk	Bat	Fox	Coyote ^a	Other	Total
Cochise	5	1	10	1	1 bobcat ^b	18
Coconino	1 ^c	5	1 ^d			7
Gila			2			2
Graham		3				3
La Paz						0
Maricopa		10	1			11
Mohave		2				2
Navajo		1				1
Pima		19	3			22
Pinal	1	2			1 bobcat	4
Santa Cruz	1					1
Yavapai			1 ^d		2 bobcat	3
Yuma		1				1
Total	8	44	18	1	4	75

^a(*Canis latrans*)

^b(*Felis rufus*)

^cpositive skunk in Coconino County was picked up in Oak Creek Canyon and was confirmed as infected with the Arizona gray fox variant of rabies.

^dpositive fox in Coconino County was from Phantom Ranch area of Grand Canyon National Park and was positive for a bat variant of rabies. The fox in Yavapai County also was positive for bat variant of rabies.

ORV PROGRAM 2003

In a continuing effort to reduce the number of confirmed rabies cases, the Wildlife Services (WS) program in Arizona embarked on 3 separate rabies research projects. The first was a skunk oral rabies placebo bait study (SORPBS), conducted in conjunction with National Wildlife Research Center (NWRC) research projects in California, Texas, Wyoming, and Louisiana. The second research project was a feral dog (*Canis familiaris*) placebo bait study. The third project was a skunk telemetry study, to determine home range and denning behavior of striped skunks in Flagstaff, Arizona.

The goal of the oral rabies bait research projects is to determine acceptance of placebo rabies vaccine baits among skunks and feral dogs. The goal of the telemetry project is to better understand skunk movement and denning behavior in skunks in Flagstaff, where a rabies outbreak occurred in 2001.

Skunk Oral Rabies Placebo Bait Study 1

This project was prompted by inconclusive findings from the tooth samples collected during the 2002 SORPBS, using Artemis Ontario Slim baits, made with vegetable extract, (Artemis Technologies, Inc., Guelph, Ontario, Canada), incorporated with tetracycline as a biomarker. Tooth samples, sent to Matson's Laboratory in

Montana, proved to be too small for tetracycline analysis. Therefore, WS duplicated the trap lines in an effort to recapture skunks tagged during the 2002 project and collect new tooth samples for analysis.

Study Area.--Study areas for this project were the same as the 2002 SORPBS. The first site was located on the Ft. Huachuca Military Post and the second site was located on the Bureau of Land Management's, Las Cienegas National Conservation Management Area; both were located in southeastern Arizona (Figure 1).

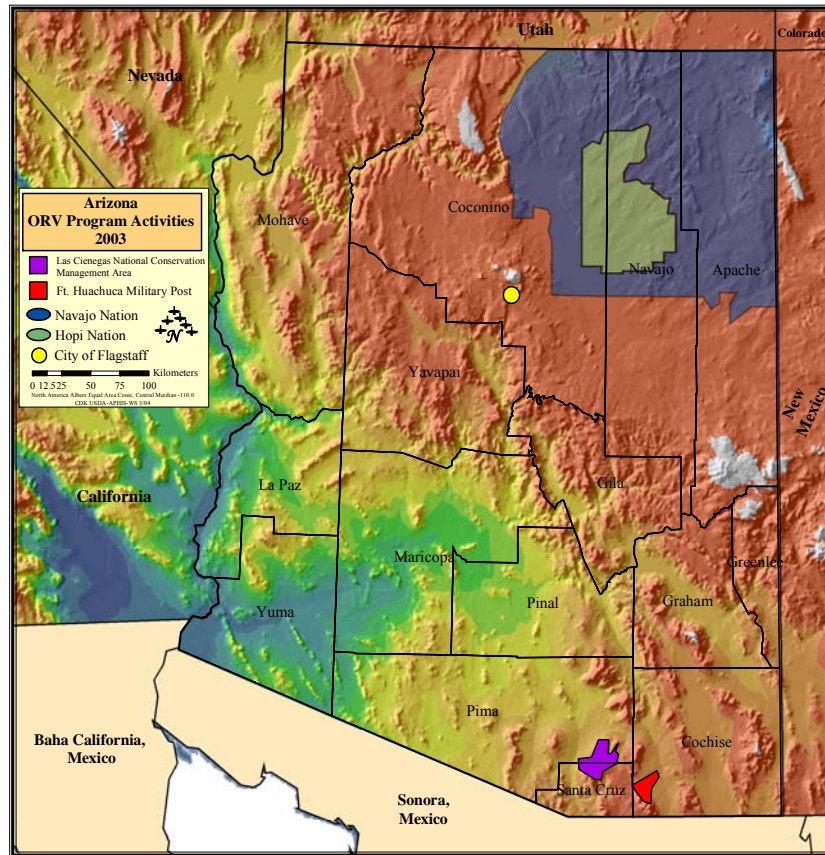


Figure 1. Oral rabies vaccination program activities in Arizona, 2003.

Methods.--Capture methods were identical to those described in the Cooperative Rabies Management Program, National Report 2002 (USDA 2002). Animals trapped after bait distribution were anesthetized with 20 mg/kg ketamine and 4 mg/kg xylazine, injected intramuscularly. Blood samples were removed for rabies titer analysis and skunks were euthanized in order to collect the remaining samples (head, jaw, tissue, and hair). All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Results.--Seventeen (17) skunks were captured. Skunk species captured included: 9 striped skunks, 7 hooded skunks (*Mephitis macroura*), and 1 spotted skunk (*Spilogale putoris*). Six (37%) of the skunks were recaptures from the 2002 study. Head samples were sent to 2 Arizona State Health Department labs for fluorescent rabies antibody testing. All head samples tested negative for rabies. Results of tetracycline analysis from teeth samples are pending.

Skunk Oral Rabies Placebo Bait Study (SORPBS) 2

The purpose of this project was to test acceptance of an alternative placebo bait. Merial Cylindrical placebo baits, made with fishmeal polymer containing tetracycline biomarker, (MERIAL Limited, Athens, Georgia, USA), were used during 2003 as an alternative to the Ontario Slim placebo baits, used during the 2002 SORPBS.

Study Area.--The second phase of SORPBS 2 began in October 2003. Two research sites were selected for the project. The first site was located on the Ft. Huachuca Military Post and the second site was located on the Bureau of Land Management's, Las Cienegas National Conservation Management Area (Figure 1). Both sites are located in southeastern Arizona, and have similar vegetation types comprised of plains, desert grassland, and Chihuahuan desert scrub (Brown 1994). The overall study areas were the same as the 2002 study areas, however, sampling transects were located in new areas. The same research protocol was used for both sites.

Methods.--Capture methods used were identical to those described in the Cooperative Rabies Management Program, National Report 2002 (USDA 2002). Trapped skunks were anesthetized with a 5:1 mixture of ketamine/xylazine injected intramuscularly. Blood samples were collected for rabies virus neutralizing antibody titer analysis. Animal were euthanized so that the head, jaw, and hair samples could be collected. All samples, excluding heads, were sent to the NWRC for analysis. Brain stem samples were sent to Arizona State Health Department labs for fluorescent rabies antibody testing.

Results.--Twenty one (21) skunks were captured. All 4 skunk species, found in Arizona, were captured; 10 striped skunks, 8 hooded skunks, 2 spotted skunks, and 1 hog-nosed skunk (*Conepatus leuconotus*). All skunks tested negative for rabies. Results of tetracycline analysis of the teeth samples are pending.

Dog Baiting Study

The study was conducted on the Navajo and Hopi Nations (located in northeastern Arizona), in conjunction with WS, Centers for Disease Control and Prevention (CDC), Navajo Veterinary Services, and Hopi Veterinary Services (Figure 1). The initial bait trial was conducted on 14 March 2003. Merial Fishmeal Polymer placebo baits were used in this initial study. The second bait trial was conducted on 11 April 2003, wherein Artemis Ontario Slim placebo baits were used.

Methods.--Two sites were selected near Chinle and its neighboring towns on the Navajo Nation. A third site was selected on the Hopi Nation. Small research groups of 2-4 individuals, which included at least 1 representative from the Navajo or Hopi Nation, hand baited as many feral dogs as possible at each site. All efforts were made to provide only 1 bait to each feral dog and observe potential uptake. Any uneaten baits were collected and removed from the study area.

Results.--Two hundred forty (240) feral dogs (79 dogs, trial 1 and 161 dogs, trial 2) were given oral rabies placebo baits (Figure 2 and Figure 3). Dogs were more apt to chew the Merial fishmeal baits, compared to the Artemis Ontario Slims, vegetable extract baits.

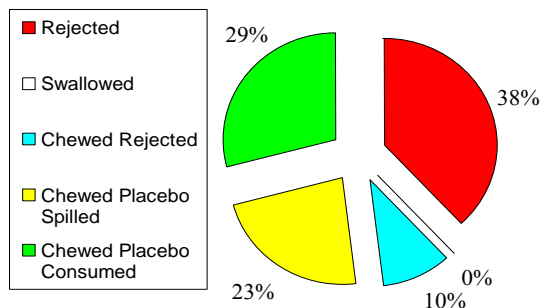


Figure 2. Feral dog preference for fishmeal baits on the Navajo and Hopi Nations, Arizona, 2003.

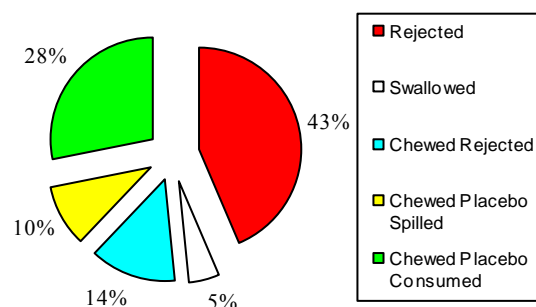


Figure 3. Feral dog preference for vegetable extract baits on the Navajo and Hopi Nations, Arizona, 2003.

Skunk Telemetry Study in Flagstaff, Arizona

The rabies epizootic in Flagstaff in 2001 was unprecedented in that bat rabies variant was being transmitted by striped skunks. Wildlife Services conducted a 6-week program (8 May-30 June 2001) to establish a Trap-Vaccinate-Release (TVR) protocol for striped skunks in the Flagstaff area (Figure 1). Coconino County Department

of Health Services and Arizona Department of Health Services, with assistance from CDC, continued the TVR throughout the summer (Worgess, personal communication). Since intervention with TVR, no skunks have tested positive for bat rabies.

In an effort to better understand skunk populations and behavior for control of rabies outbreaks in Arizona, WS, in cooperation with Northern Arizona University, initiated research designed to address the following questions: (1) where do urban skunks den and what are their denning behaviors, (2) do skunks den communally in Flagstaff, (3) was there potential for skunk to skunk rabies transmission, due to communal denning, (4) was there potential for rabies to be spread from skunk to skunk, due to translocation, (5) what are striped skunk home range sizes in Flagstaff's urban environment, and (6) how can we apply this knowledge to future control programs.

Study Area.--Flagstaff's urban habitat was delineated into 2 categories. Wildlife Services focused on the urban matrix and the urban/wildland matrix interface. The urban matrix is described by urban disturbance and development, paved streets, housing districts, and business districts. The urban/wildland matrix interface is at the periphery of the urban matrix, where housing is located adjacent to managed, but undeveloped habitat, (i.e., Forest Service controlled and managed land within city limits).

Both study areas were confined to east Flagstaff. The urban/wildland matrix interface bounds the western side of East Flagstaff, along Switzer Mesa and the north side of Flagstaff, near Mount Elden. The interior of this area was determined to be urban matrix.

Methods.--Live-trapped skunks were equipped with radio collars to determine home range sizes, den locations, and diurnal and nocturnal behaviors. Radio-equipped skunks will be re-captured and translocated away from their home ranges to determine if they return to their previous home ranges (homing behavior) or if new home ranges are established.

Results.--The telemetry study in Flagstaff began in fall 2003. To date, 12 skunks have been captured and equipped with radio collars.

Other Rabies Activities

Wildlife Services provided direct control and technical support in Maricopa County for control of nuisance animals in response to potential rabies threats and children bitten by coyotes. Also, in an effort to decrease the number of rabies threats, WS hired a Wildlife Specialist for Cochise County, which is one of Arizona's rabies "hot spots".

In a joint effort, Arizona's WS program and NWRC submitted a manuscript which was accepted and published in the Journal of Wildlife Disease (Engeman et al. 2003).

Non-target Captures

Non-target animals that were captured and released included: 12 desert cottontail rabbits (*Sylvilagus auduboni*), 1 cotton rat (*Sigmodon hispidus*), 1 Mexican woodrat (*Neotoma mexicana*), 22 white-throated woodrats (*Neotoma albigula*), 3 ringtails (*Bassariscus astutus*), 1 gray fox (*Urocyon cinereoargenteus*), 1 opossum (*Didelphis virginiana*), and 1 western scrub jay (*Aphelocoma californica*). Non-target animals that were captured and euthanized included: 5 white-throated woodrats.

ORV PROGRAM 2002-EVALUATION

Twenty seven (27) skunks were captured at the end of the initial 2002 SORPBS. Sixteen (16) of the individuals captured were hooded skunks, 9 were striped skunks, and 2 were spotted skunks. Results from tooth samples were inconclusive. The first premolar was found to be too small for reliable tetracycline analysis.

SUMMARY

During 2003, WS completed the second year of the SORPBS. Wildlife Services also initiated the first year of the feral dog placebo bait study and the Flagstaff skunk telemetry study. Wildlife Services will be testing 2 new baits in the SORPBS in the fall of 2004. Plans have been made to test 3 baits in the feral dog placebo bait study in April 2004. The skunk telemetry study in Flagstaff is on-going and will continue as a graduate research project.

It is the goal of the Arizona WS program to continue to provide support and to respond to requests for rabies surveillance and management. Wildlife Services looks forward to a strong cooperative relationship with state and local agencies, while providing federal leadership in rabies management.

LITERATURE CITED

Brown, D. 1994. Biotic communities: Southwestern United States and Northwestern Mexico. University of Utah Press, Salt Lake City, Utah, USA.

Engeman, R., K. Christensen, M. Pipas, and D. Bergman. 2003. Population monitoring in support of a rabies vaccination program for skunks in Arizona. *Journal of Wildlife Disease*, 33(3): 746-750.

USDA. 2002. Cooperative rabies management program: national report 2002. USDA, APHIS, Wildlife Services, Concord, NH, USA.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM CALIFORNIA 2003

BACKGROUND

California has a unique strain of rabies in skunks (*Mephitis mephitis*) and strains of rabies in insectivorous bats (order *Chiroptera*). Rabies in skunks has remained enzootic over major areas of the state since at least 1945. Rabies among other species of wildlife (raccoons [*Procyon lotor*], opossums [*Didelphis virginiana*], various canids, etc.) is episodic spillover and not maintained in these species in California. The skunk strain has been limited to areas north of the Tehachapi mountain range in California. From 1993-2002, the California Department of Health Services (CDHS) reported 3,312 cases of rabies throughout the state, approximately 51% of these occurred in skunks.

ORV PROGRAM 2003

In 2003, the California Wildlife Services (WS) program, in conjunction with the WS, National Wildlife Research Center (NWRC) began conducting the first of a series of skunk placebo oral rabies vaccine (ORV) bait research projects. This is part of a larger project that is being conducted in Arizona, Louisiana, Texas, and Wyoming. The goal is to compare various formulations of placebo baits and determine bait acceptance in skunks. The optimal bait formulation derived from these studies will likely be the best candidate for delivering oral rabies vaccine (ORV) to skunks. Currently, there is no oral rabies vaccine effective for use in skunks in the United States. However, there are prospective vaccine candidates.

Since 1921, rabies is a legally reportable disease under the California Code of Regulations, Title 17, Section 2500. The CDHS, Veterinary Public Health Section is responsible for the surveillance, prevention, and control of rabies in California. Currently, only animals that are exhibiting behavior or circumstances consistent with or pertinent to rabies, or those involved in potential exposure incidents are tested for rabies.

Cost-benefit Analysis Study

The CDHS was awarded funds from the WS program to participate in a cost-benefit analysis of using ORV (Figure 1). Given that there is currently no effective vaccine, this study is based on control models likely to be applied in the field to possibly eliminate skunk rabies in high risk regions in California. This study was warranted to explore the feasibility of using ORV to control a strain of skunk rabies unique to California. Final results from this study will be available in April-May 2004.

Skunk Placebo Bait Study

In 2003, the California WS program conducted a placebo ORV bait research project in Siskiyou County (Figure 1). Two types of placebo baits, Artemis Ontario Slim baits (Artemis Technologies, Inc., Guelph, Ontario, Canada), made with vegetable extract containing a tetracycline biomarker and Merial Cylindrical baits (MERIAL Limited, Athens, Georgia, USA), made with fishmeal polymer and also containing a tetracycline biomarker, were distributed on 2 sites at a density of 75 baits/km², along 3 transects covering an area of 27 km² (totaling 2,025 baits of each type). Live traps were placed every 0.5 km along each transect approximately 6 weeks after baits were distributed. Upon capture, each animal had blood drawn for rabies virus neutralizing antibody to rabies detection and the lower jaw bones were removed and sent to Johnston Biotech, Ontario, Canada to be tested for tetracycline biomarker.

Eighty eight target animals (striped skunks) were captured and tested. Additionally, several non-target animals captured also were tested for presence of the biomarker. All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

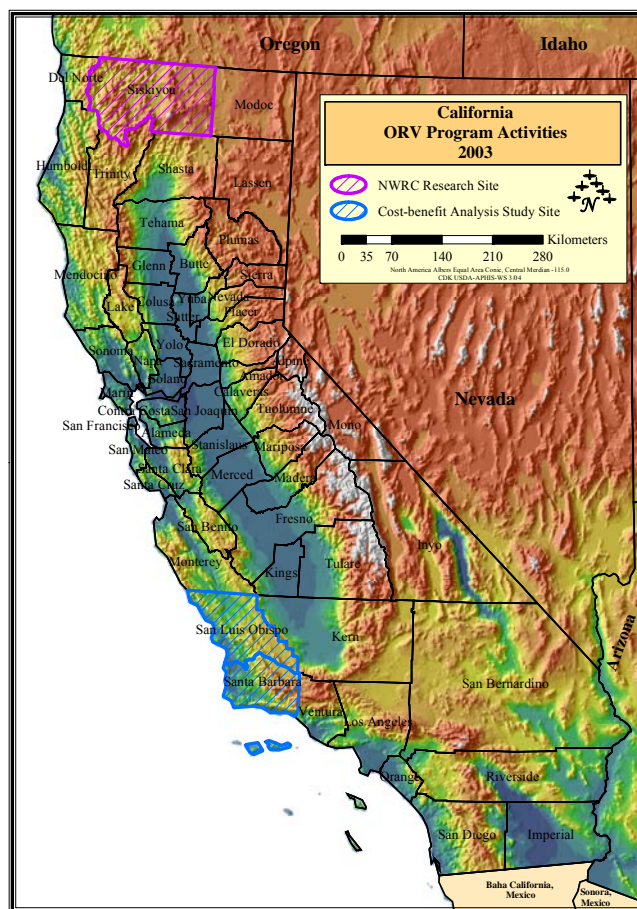


Figure 1. Oral rabies vaccination program activities in California, 2003.

Skunk Placebo Bait Study-Evaluation

Preliminary test results of 51 striped skunk jawbones yielded 53% and 36% positive for biomarker, Merial Cylindrical baits and Artemis Ontario Slim baits, respectively. Serologic analysis data are pending. Results of non-target jawbones have not been obtained. The heads of all animals captured were submitted to the CDHS for rabies testing. To date all samples submitted to CDHS have been negative for rabies.

Non-target Captures

Non-target species captured and euthanized included: 21 raccoons (*Procyon lotor*), 13 California ground squirrels (*Spermophilus beecheyi*), 10 opossum (*Didelphis virginiana*), 1 bobcat (*Felis rufus*), and 1 gray fox (*Urocyon cinereoargenteus*).

SUMMARY

In 2003, the California WS program concentrated mainly on identifying areas to conduct skunk placebo ORV bait studies. In 2004, a similar skunk placebo ORV study will be conducted in Sutter County. Captive skunk bait acceptance studies are being conducted at NWRC to ascertain skunk responses to varying bait sizes, shapes, and flavors that could potentially be tested in field conditions in California during 2004. The California WS program will continue working with NWRC and the CDHS on the development of an ORV bait for use in skunks in California.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM FLORIDA 2003

BACKGROUND

Raccoon (*Procyon lotor*) rabies was first documented in the State of Florida in 1947. It is now enzootic throughout the entire State. Raccoon rabies was likely translocated by raccoon hunters from Florida to the Mid-Atlantic States in the late 1970s, where it began to spread throughout the eastern United States and as far north as southern Ontario and eastern New Brunswick, Canada. An effective raccoon oral rabies vaccination (ORV) program in Florida would constitute an important southern component in the National ORV program.

Wildlife Services (WS) worked in cooperation with the Florida Department of Agriculture and Consumer Services (FDACS), Division of Animal Industry; the Florida Department of Health; the Florida Fish and Wildlife Conservation Commission; the Southwest Florida Water Management District; and the Florida Park Service. In addition, WS gained the support of many county and city agencies to aid with the planning and the implementation of the 2003 ORV bait drop. Local agencies spent \$155,869 to conduct ground and helicopter distribution of baits. The FDACS, the lead state agency for the Florida ORV program, spent \$112,349 to plan and conduct ground and aerial distribution of the baits. Wildlife Services costs, associated with 2003 ORV program activities, totaled \$1,115,534 (Table 1).

Table 1. Fiscal Year 2003 budget for the Florida ORV program.

Item	WS Cost
Fishmeal polymer baits	\$635,644
Aircraft contracts/fuel	\$91,000
Lab testing for teeth	\$612
Salaries and benefits	\$165,856
Wildlife Services (education, equipment, travel, utilities, etc.)	\$222,422
Total	\$1,115,534

ORV PROGRAM 2003

Bait Distribution

The objective of the Florida ORV program was to expand the success of the Pinellas County ORV program, initiated in 1995, by establishing a vaccination zone in areas of high human population along the Interstate 4 corridor (Figure 1). The first phase of this objective was accomplished in February 2003. The ORV bait zone in Florida encompassed 6,293 km² (2,458 mi²) (Figure 1). The zone encompassed portions of Hernando, Hillsborough, Lake, Pasco, Polk, Sumter, and Pinellas Counties. During the February bait drop, 270,234 fishmeal polymer (FMP) baits, containing Raboral V-RG® vaccine (MERIAL Limited, Athens, Georgia, USA), were distributed by air, while 230,273 baits were distributed by hand. Total number of FMP baits distributed within the Florida barrier during the 2003 baiting was 500,507. Baits distributed during the 2003 baiting cost \$1.27 each. The FMP baits were distributed by air at a rate of 75 baits/km². Aircraft and flight crew for the 2003 ORV program were provided by Dynamic Aviation. Ground and aerial baiting support were provided by WS, FDACS, and county and municipal agencies.

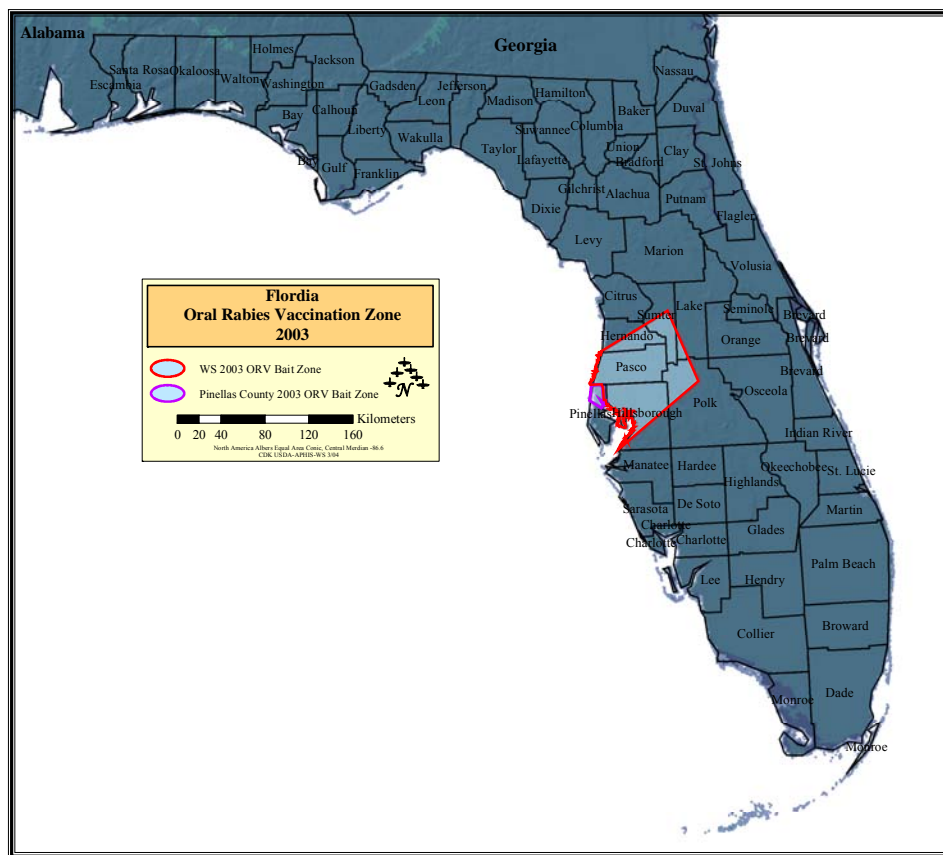


Figure 1. Oral rabies vaccination zone in Florida, 2003.

Population Monitoring

On 27 June 2003, WS began relative density studies of raccoon populations within the ORV bait zone. The first counties examined in the density study included Polk, Sumter, and Hillsborough (Table 2). Blood serum samples were collected from 277 raccoons and sent to Centers for Disease Control and Prevention (CDC) for antibody testing. All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Table 2. Results of raccoon relative density (raccoon/km²) trapping efforts in Polk, Sumter, and Hillsborough Counties, Florida, 2003.

	Trapping sites				
	Polk	Sumter	Hillsborough 1	Hillsborough 2	Hillsborough 3
Macrohabitat	Forest	Wetland	Urban	Urban	Urban
Trap nights	500	500	500	500	500
Unique raccoons	56	21	62	95	43
Recaptured raccoons	39	15	32	49	18
Total raccoons	95	36	94	144	61
Trap success ^a	11.2%	4.2%	12.4%	19.0%	8.6%
Non-target captures	60	57	121	96	125
Area (km ²)	3.78	2.20	3.15	3.26	3.75
Raccoon relative density	15	10	20	29	11

^aunique raccoons

Other Rabies Activities

In May 2003, a woman in Hillsborough County was attacked by a raccoon while sweeping her porch. The raccoon tested positive for rabies and WS was called in to depopulate the area. Sixteen raccoons were trapped in the area; none displayed positive serum titers, nor did they test positive for rabies.

Non-target Captures

Non-target species captured and released included: 357 opossums (*Didelphis virginiana*), 72 gray foxes (*Urocyon cinereoargenteus*), 14 feral cats (*Felis catus*), 7 nine-banded armadillos (*Dasypus novemcinctus*), 6 turtles (species unknown), 2 Eastern cottontail rabbits (*Sylvilagus floridanus*), and 1 bobcat (*Felis rufus*).

ORV PROGRAM 2002-EVALUATION

From October 2002-January 2003, WS conducted pre-bait ORV surveillance activities to establish baseline comparison data for rabies antibody titer levels, age, and tetracycline biomarker presence in raccoons, within the planned ORV zone (Table 3). Age and tetracycline biomarker data are not yet available.

Table 3. Serology results of raccoon biological samples collected during pre-bait ORV evaluation in Florida, October 2002-January 2003.

	Pre-bait ORV
Serology	
Unique raccoons	201
Testable blood samples	201
Positive for rabies antibodies ^a	16 (8.0%)

^aCDC serum dilution ≥ 5

SUMMARY

During 2003, WS completed the second year of cooperative participation in the Florida ORV program. The focus of activity in 2003 was the bait drop and initiating relative density studies in the ORV bait zone area. A total of 500,507 baits were distributed by fixed-wing plane, helicopter, and by ground baiting activities across 6 counties encompassing 6,293 km². Florida's baiting effort is an extension of the successful Pinellas County ORV program.

In 2004, Florida will continue to participate in the ORV program. Enhanced surveillance and relative density studies will be increased in 2004, with efforts to start expanding the bait zone.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM GEORGIA 2003

BACKGROUND

Raccoon (*Procyon lotor*) rabies was first documented in Florida in 1947. As the disease spread in wild populations it moved progressively northward, entering South Georgia at least 40 years ago. Raccoon rabies is now enzootic throughout the state. During the past 3 years Georgia has averaged 404 cases (402 cases-2001, 411 cases-2002, and 399 cases-2003) of animal rabies per year.

ORV PROGRAM 2003

The spring of 2003 marked the first year of Georgia's Wildlife Services (WS) involvement in the raccoon oral rabies vaccination (ORV) program. Initially, Georgia's program was designed only to involve enhanced rabies surveillance in the northwest portion of the state, by implementing a road kill/nuisance animal surveillance project. By late summer it was determined that the distribution of fishmeal polymer (FMP) baits containing Raboral V-RG® vaccine (MERIAL Limited, Athens, Georgia, USA), would occur as part of the Georgia-Alabama-Tennessee (GAT) barrier zone. It is hypothesized that the higher elevations of the Appalachian Mountains in eastern Tennessee and the Alabama-Coosa River system in Alabama appear to be acting as natural barriers, slowing the westward spread of raccoon rabies. The GAT zone was established to fill the gap between these natural barriers.

Bait Distribution

The Georgia section of the GAT zone included portions of Catoosa, Chattooga, and Walker Counties, and all of Dade County (Figure 1). Beginning on 14 November 2003, 98,629 FMP vaccine baits were distributed (69,317 by air and 29,312 by hand) in a 1,201.83 km² area. Post-bait ORV trapping and evaluation was set to begin in January 2004.

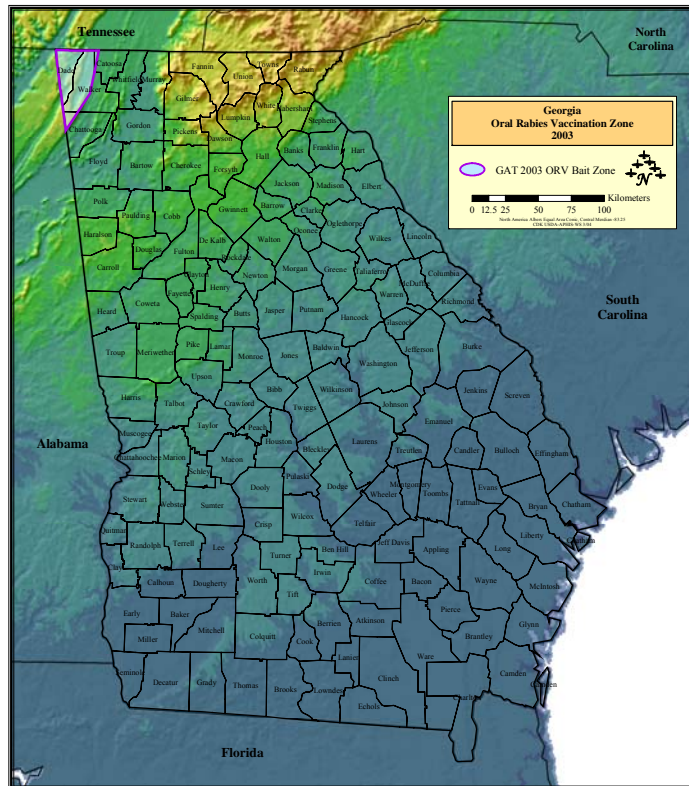


Figure 1. Oral rabies vaccination zone in Georgia, 2003.

Surveillance

In April 2003, a road kill enhanced surveillance program was established. Nuisance wildlife caught by local animal control agencies were also submitted for testing. One hundred seventy four (174) samples, from a 5-county area in northwest Georgia, were submitted to the Centers for Disease Control and Prevention (CDC) for testing (Table 1). Eight species of animals were sampled, they included: bats (order *Chiroptera*), cat (*Felis cattus*), coyote (*Canis latrans*), dog (*C. familiaris*), gray fox (*Urocyon cinereoargenteus*), raccoon, red fox (*Vulpes vulpes*), and striped skunks (*Mephitis mephitis*). Results determined that 19 of 174 (9.2%) animals submitted were positive for rabies. These 19 animals were located within 3 counties (Table 1). All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Table 1. Road kill/nuisance animal samples, collected by county and species in Georgia, 2003.

County	Bat	Cat	Coyote	Dog	Gray fox	Raccoon	Red fox	Skunk	Total
Catoosa		1	2		1	35 (8 positive)		3	42
Chattooga			1			8			9
Dade					3	12 (2 positive)	1		16
Walker	1 positive	4	2	1	3	71 (5 positive)		12 (3 positive)	94
Whitfield	1	2			1	9			13
Total	2 (1 positive)	7	5	1	8	135 (15 positive)	1	15 (3 positive)	174

SUMMARY

During the first year of Georgia's involvement in the ORV program a significant amount of time was spent establishing communications and relationships with cooperators. Emphasis also was placed on a public relations campaign, to educate and inform the general public about the ORV program and raccoon rabies. Cooperators assisted in various aspects of the ORV program, including providing public information, aerial and hand bait distribution, and road kill surveillance. Cooperators in the GAT ORV program were: WS, Georgia Department of Public Health, Georgia Department of Agriculture, Georgia Department of Natural Resources, and CDC. Additional support on the local level was provided by Catoosa County Animal Control, Dade County Animal Control, Walker County Animal Control, and the City of Chickamauga Police Department.

Plans for Georgia's WS 2004 involvement in the ORV program are post-bait raccoon trapping and the continuation of road kill/nuisance animal surveillance. The distribution of baits in the GAT zone will continue through the established cooperative relationships with state, federal, and local governments.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM KANSAS 2003

BACKGROUND

In 2003, Kansas reported 164 positive rabies cases. Striped skunks (*Mephitis mephitis*) accounted for 123 (75%) of the positive cases. These numbers represent near record levels of skunk rabies for the state. Northeast Kansas is 1 of several areas in the state that appear to be a “hot spot”. Personnel from Kansas Wildlife Services (WS) program, Kansas State University College of Veterinary Medicine Rabies Lab (KSUCVM), and the Fort Riley Military Installation (FRMI) have worked cooperatively to collect information on skunk rabies from the striped skunk population found on FRMI, located in northeast Kansas (Figure 1).

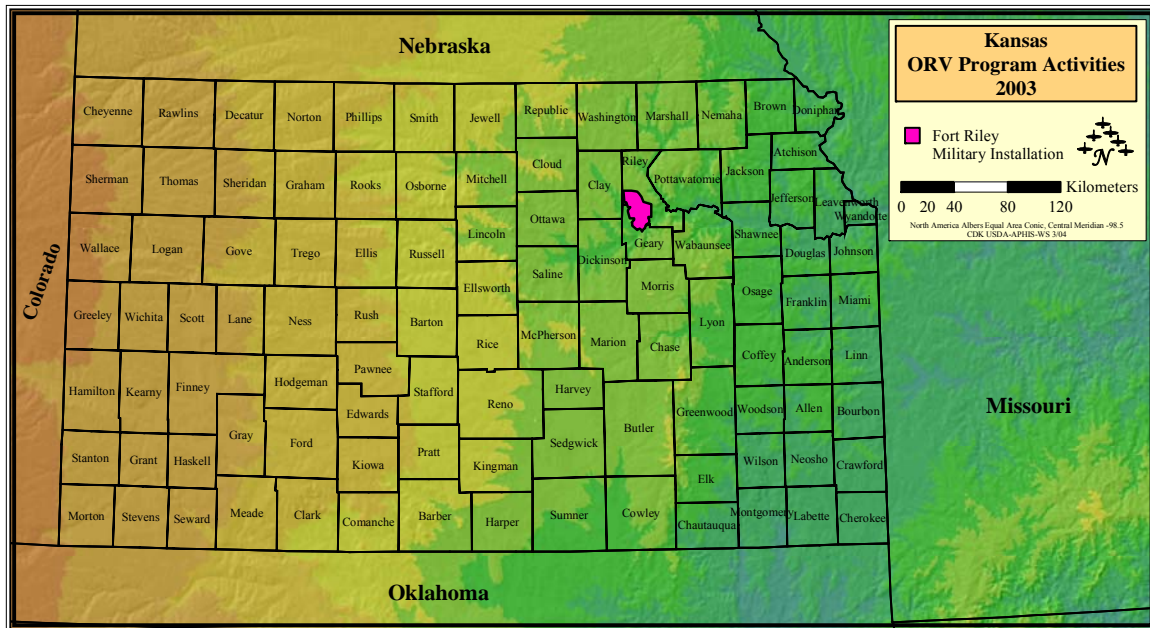


Figure 1. Location of the Fort Riley Military Installation, Kansas, 2003.

Wildlife Services currently has a full-time wildlife biologist stationed at FRMI, who has, over the last few years, collected skunks on the installation that have tested positive for rabies. Wildlife Services also regularly removes 30-50 nuisance skunks each year while responding to routine nuisance complaints on FRMI. Due to WS existing presence at FRMI and the nature of the land available to sample both urban and rural animal populations, WS decided that this was an ideal situation to monitor rabies and conduct relative density studies of striped skunk and raccoon (*Procyon lotor*) populations. In addition, WS believed this would be an excellent opportunity to conduct placebo baiting and oral rabies vaccination (ORV) trials if these programs were to expand to other states.

ORV PROGRAM 2003

Population Monitoring

In addition to regular enhanced surveillance, such as testing suspect animals during routine nuisance control, WS conducted 3 relative density studies according to the national rabies management program protocol. Two density studies were conducted in the rural training areas of FRMI and the third was conducted in a heavily populated, urban area on FRMI (Table 1). Hair samples from each raccoon captured also were collected for use in a DNA comparison study. Initial results of the relative density studies show similar densities among urban and rural striped skunks. Raccoons however, showed significantly higher densities in the urban area. All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Table 1. Results of 3 relative density studies (skunks/km² and raccoons/km²) conducted on the Fort Riley Military Installation, Kansas, 2003.

	Summer (urban)	Summer (rural)	Fall (rural)
Trap nights	500	500	400
Unique skunks	3	3	7
Unique raccoons	58	24	19
Trap success ^a	skunks 0.6% / raccoons 11.6%	skunks 0.6% / raccoons 4.8%	skunks 1.7% / raccoons 4.7%
Non-targets	24	7	8
Relative density	skunks 1 / raccoons 19.3	skunks 1 / raccoons 8	skunks 1.9 / raccoons 5.1 ^b

^aunique skunks and unique raccoons

^brelative density estimates adjusted for 400 trap nights

Non-target Captures

Thirty nine opossums (*Didelphis virginiana*) were captured and euthanized.

SUMMARY

The number of rabies cases has slowly climbed from 37 cases, in 1996, to near record levels of 164 cases in 2003. This is the first year that WS has been involved with the National Rabies Program and there was strong cooperative support from FRMI and KSUCVM for the work that was accomplished this year. Cooperators have expressed interest in continuing rabies monitoring in skunks and perhaps expanding monitoring efforts for bats as well.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM KENTUCKY 2003

BACKGROUND

The Kentucky oral rabies vaccination (ORV) program was launched in 2002 as part of Wildlife Services (WS) national program to stop the westward spread of the raccoon (*Procyon lotor*) strain rabies. In an effort to obtain baseline information on raccoon populations in Kentucky and actively search for raccoon rabies west of the Appalachian Ridge ORV barrier, WS decided to begin conducting relative density studies and enhanced surveillance through collecting and testing road-killed animals in the eastern counties bordering West Virginia and Ohio.

The Kentucky ORV program is being conducted by WS in cooperation with the Kentucky Department of Fish and Wildlife Resources (KDFWR) and the Centers for Disease Control and Prevention. The Kentucky Department of Forestry and the KDFWR provided access to state owned properties for ORV program trapping and monitoring.

ORV PROGRAM 2003

Surveillance

In 2003, WS contracted with the KDFWR to conduct enhanced surveillance for raccoon strain rabies in Kentucky (Figure 1). Thirteen raccoons were collected from 4 counties on road kill survey routes. All raccoons tested negative for rabies.

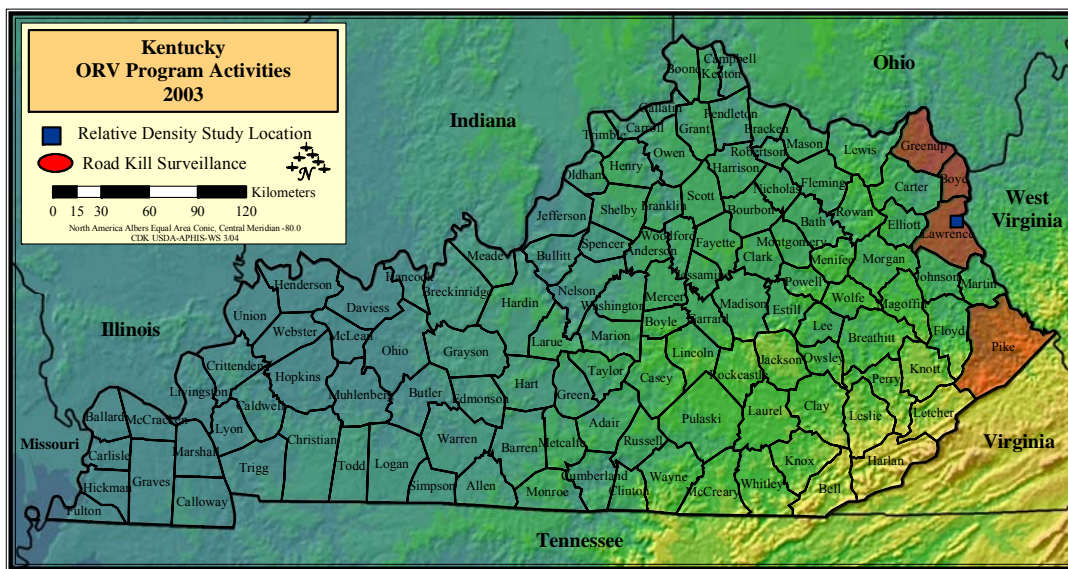


Figure 1. Location of road kill surveillance and a relative density study in Kentucky, 2003.

Population Monitoring

Wildlife Services protocol to index relative population density was used in Kentucky during 2003. One density study was conducted in October 2003 (Figure 1). The Yatesville Lake Wildlife Management Area was situated at 213 meters in elevation and consisted primarily of eastern hardwood forest, interspersed with fallow fields. Two unique raccoons were captured resulting in an estimated relative density of 0.6 raccoons/km². All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Non-target Captures

Non-target species that were captured and released during the relative density study included: 35 opossums (*Didelphis virginiana*), 4 Eastern cottontail rabbits (*Sylvilagus floridanus*), 11 striped skunks (*Mephitis mephitis*), 5 feral dogs (*Canis familiaris*), and 1 Eastern box turtle (*Terrapene carolina carolina*).

SUMMARY

In 2003, Kentucky WS conducted its second year of raccoon relative density estimates. Enhanced surveillance efforts (road kill surveys) resulted in the collection and testing of 13 animals, all tested negative for raccoon strain rabies.

During 2004, WS will continue to conduct and coordinate enhanced surveillance for raccoon strain rabies in eastern Kentucky. Surveillance efforts will expand from 4 counties to 18 counties bordering Ohio, West Virginia, and Virginia. Additional relative density studies will be conducted to compare raccoon population characteristics between northeastern and southeastern Kentucky.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM LOUISIANA 2003

BACKGROUND

To date, there have been no reported cases of raccoon (*Procyon lotor*) strain rabies in Louisiana, although other strains (including bat [Order *Chiroptera*] and striped skunk [*Mephitis mephitis*]) do occur. In an effort to detect possible entry of this strain into the State, Wildlife Services (WS) initiated surveillance of road-killed raccoons in the eastern halve of Washington and St. Tammany Parishes in October 2003. Wildlife Services also participated in skunk bait studies being conducted by the National Wildlife Research Center (NWRC), Ft. Collins, Colorado.

ORV PROGRAM 2003

Surveillance

Contact was made with representatives of the Louisiana Department of Wildlife and Fisheries, Louisiana Department of Health and Hospitals, Parish Sheriff Departments, Parish Animal Control Shelters, and local law enforcement agencies to discuss and plan enhanced surveillance activities. All contacts were asked to report any sick or abnormally-behaving animals to WS so that they could be processed and tested for rabies. Entities contacted were supportive of this project.

From 1 October-31 December 2003, WS specialists completed daily, early-morning surveys of the major State and Federal Highways in eastern Washington and St. Tammany Parishes to search for road-killed raccoons and other small carnivores (Figure 1). Results were disappointing because only 5 usable brain stems were collected and processed, despite the fact that specialists worked 63 staff days and drove more than 11,587 km (7,200 miles), a daily average of 184 km (114 miles).

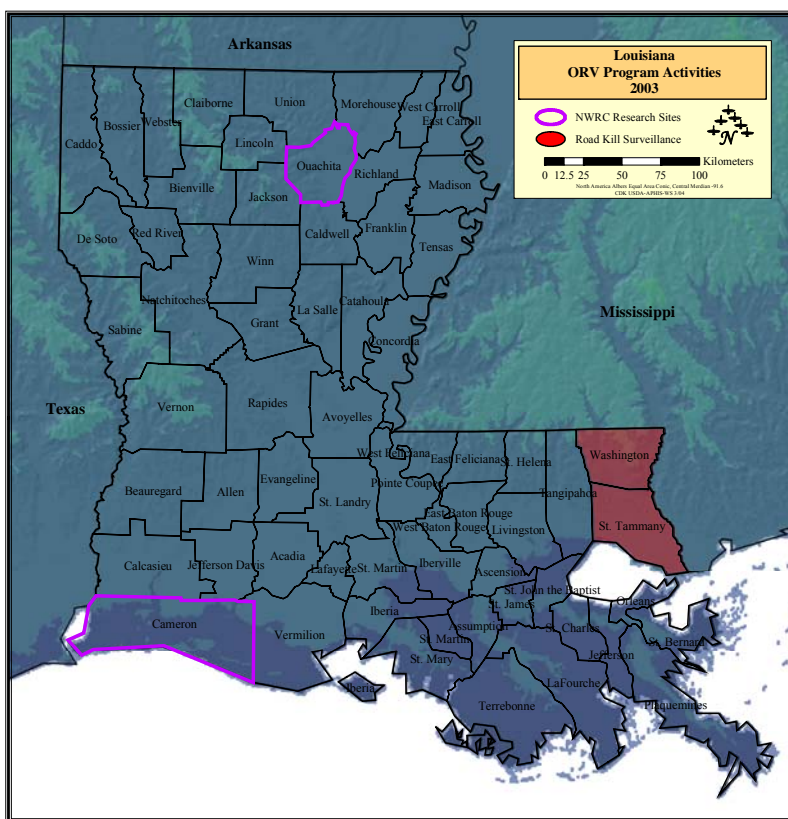


Figure 1. Oral rabies vaccination program activities in Louisiana, 2003.

The following factors may have caused low numbers of road-killed raccoons and small carnivores to be collected in the surveyed area: (1) suppressed populations of small carnivores (may be related to distemper outbreaks during the last few years); (2) animals struck by vehicles were thrown, or ran from roads upon impact; or (3) freshly-killed animals were being removed from roadbeds by humans or scavengers. No sick or abnormally-behaving animals were reported to our specialists during this period. All animals collected in 2003 were handled according to the American Veterinary Medical Association guidelines.

Other Rabies Activities

Louisiana WS personnel assisted NWRC personnel in conducting 2 trials of 2 different types of baits that could potentially be used to deliver a skunk oral rabies vaccination (ORV). Study sites were located in northeast and southwest Louisiana, Ouachita and Cameron Parishes, respectively (Figure 1). Louisiana personnel assisted in setting up the studies, capturing small carnivores on the study areas, and processing biological specimens for shipment to analytical labs. Results are pending.

SUMMARY

This was the first year of operational rabies work in Louisiana. Although the number of enhanced rabies surveillance samples was disappointing, we have been given the opportunity to identify potential new rabies-related projects and have begun the process of establishing the WS National Rabies Management Program as a reliable and trustworthy source of information and leadership.

In 2004, Louisiana WS plans to continue participation in the NWRC ORV skunk bait study, as well as expand its enhanced surveillance activities in eastern Louisiana, to include initiation of a small raccoon relative density study in the Pearl River drainage.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM MAINE 2003

BACKGROUND

The rabies virus was first documented in Maine in 1933 when 59 domestic dogs (*Canis familiaris*) and 3 sheep (*Ovis aries*) were confirmed positive by the Maine State Health and Environmental Testing Laboratory (MHETL) in Augusta (MHETL 2003). A human death from rabies occurred in 1934, during a period when only the “Canadian red fox” (*Vulpes vulpes*) strain was known to be circulating through the state (Okey 1971). In 1994, the first indigenous case of the mid-Atlantic raccoon (*Procyon lotor*) strain of rabies was confirmed in a skunk (*Mephitis mephitis*) from southern Maine (MHETL 2003). This current epizootic primarily affects raccoon and striped skunk populations in southern Maine. Since 1994, there have been 1,257 confirmed positive cases of rabies in Maine. Raccoons alone accounted for 665 (63%) of these cases (Table 1). Although annual numbers have declined, rabies continues to move north and east through Maine. During 2003, there were 82 positive rabies cases reported by the MHETL. The enhanced surveillance of raccoon populations helps determine the status and movement of the rabies virus. Wildlife Services (WS) has conducted enhanced surveillance by acquiring road-killed and euthanized sick mammals from northern Maine. These animals are submitted for rabies testing at the MHETL. The focus areas of enhanced rabies surveillance efforts occurred in the less populated areas of Maine, where rabies is more likely to spread without timely human detection.

Table 1. Confirmed positive rabies cases in Maine, 1994-2003 (MHETL 2003).

Year	Positive rabies cases	Positive raccoons
1994	10	0
1995	43	41
1996	131	53
1997	244	130
1998	248	143
1999	208	116
2000	139	73
2001	85	34
2002	67	37
2003	82	38
Total	1,257	665 (63%)

ORV PROGRAM 2003

The first Maine oral rabies vaccination (ORV) project was a cooperative effort among WS, Cornell University, Maine Department of Health, and Maine Department of Agriculture. Cornell University is the lead coordinating agency for this project. The Ontario Ministry of Natural Resources also played an active role in providing aircraft and flight crews for vaccine distribution. Project assistance also was provided by Maine Department of Inland Fisheries and Wildlife. Volunteers and support from local Maine communities and from neighboring New Brunswick, Canada citizens also contributed to the success of implementing the ORV project.

Wildlife Services has provided federal leadership by continuing to play an active role in: project planning and coordination, organizing ground support for the bait drop, working in and navigating aircraft to distribute baits, and coordinating the hand distribution of baits in areas too populated to bait by air. In addition, WS provides surveillance and follow-up field work by collecting blood and tooth samples from live-trapped animals and brain stem samples from suspect-rabid animals within the ORV bait zone.

Bait Distribution

The 2003 ORV project was based out of the Houlton International Airport in Houlton, Maine from 23-24 August (Figure 1). The 2-day event included the distribution of 276,500 baits (236,000 coated sachet [CS] and 40,500 fishmeal polymer [FMP]), containing Raboral V-RG® (MERIAL Limited, Athens, Georgia, USA), by aerial delivery in northeastern Maine at a density of 70/km². Five hundred of the FMP baits were distributed by hand,

within the city of Houlton (Figure 1). Fishmeal polymer baits contained a tetracycline biomarker. Baits cost were \$1.00/bait and \$1.27/ bait, CS and FMP, respectively. The ORV bait zone encompassed 4,200 km² (1,600mi²) of northeastern Maine along the United States/Canada border (Figure 1). The goal of the 2003 ORV program was to begin achieving sufficient levels of rabies immunity in the raccoon populations that would help prevent the northward spread of rabies to uninfected areas of Maine.

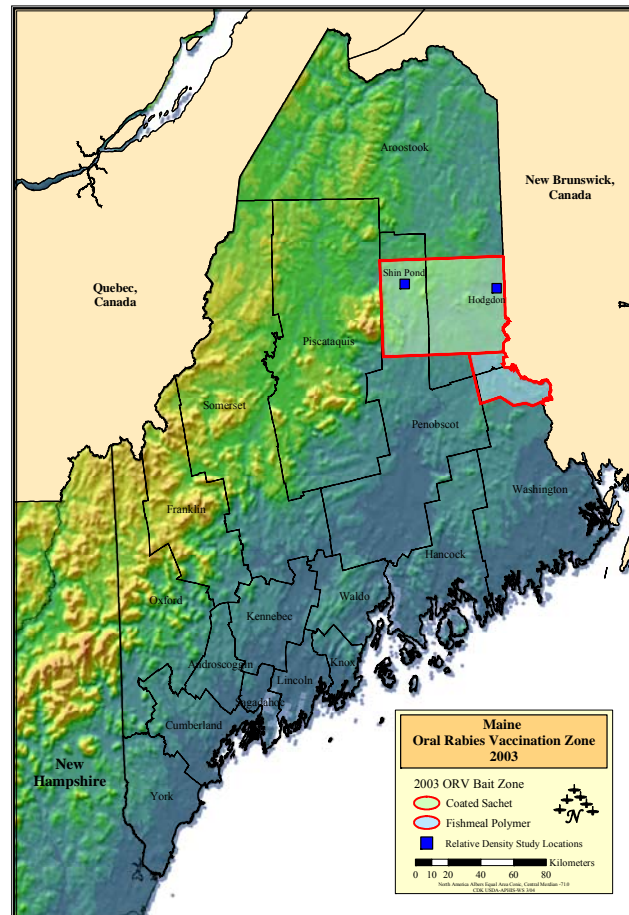


Figure 1. Oral rabies vaccination zone in Maine, 2003.

Surveillance

Wildlife Services collected 24 road-killed raccoon specimens in and around the ORV zone as part of enhanced rabies surveillance. All road kill specimens collected tested negative for rabies.

Population Monitoring

Wildlife Services conducted 2 raccoon relative density studies in northeast Maine during July, August, and September 2003 (Figure 2). Methods involved in the raccoon relative density studies included setting 50 live traps, throughout a 3 km² area, for 10 consecutive nights. Data collected included: blood serum for pre-ORV baseline rabies antibody levels, blood serum for post-ORV antibody levels, number of animals captured, age and sex ratios, and health status of the population sample. All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

The first raccoon relative density study was conducted from 28 July-8 August, 2003 and was located within Penobscot County, near Shin Pond, ME (Figure 2). The habitat primarily consisted of commercial forest land and seasonal residential structures, near a 121.4 hectare body of water. The study site was approximately 300m above sea level. Eleven unique raccoons were captured (5 adult males, 5 adult females, and 1 juvenile female), yielding an

estimated relative density of 4 raccoons/km² (Table 2). Non-target species captured and released unharmed included: 1 black bear cub (*Ursus americana*), 1 fisher (*Martes pennanti*), 1 gray squirrel (*Sciurus carolinensis*), and 4 red squirrels (*Tamiasciurus hudsonicus*). All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Table 2. Raccoon relative density surveys (raccoon/km²) in Maine, 2002-2003.

Year	Location	Density	Habitat type	Elevation
2002	Hodgdon, ME	6	Agricultural/ forest	166m
2002	Codyville, ME	1	Forest	66m
2003	Shin Pond, ME	4	Forest	300m
2003	Hodgdon, ME	4	Forest	166m

The second density study was located within Aroostook County, 5 miles west of New Brunswick, Canada, in the town of Hodgdon, ME (Figure 2). The entire study area was encompassed by the Lt. Gordon Manuel Wildlife Management Area. Habitat types included forest, agriculture, and wetland. The study site was approximately 120m above sea level. This study was conducted from 15-26 September, 2003. Similar to the previous study, 11 unique raccoons were captured (5 adult males, 5 adult females, and 1 juvenile male), yielding an estimated relative density of 4 raccoons/km² (Table 2). Non-target species captured and released unharmed included: 6 pine martens (*Martes americana*), 4 snowshoe hares (*Lepus americanus*), 2 fishers, and 1 skunk.

Post-bait Evaluation

Wildlife Services played an essential role conducting post-ORV trapping throughout the ORV zone, which included parts of Aroostook, Washington, and Penobscot Counties. One hundred and eight (108) raccoons were captured, handled, and released within the ORV zone during September and October 2003. Biological data collected from each animal included: blood, upper premolar 1, sex/weight/age, assessed general health, GPS location, and hair. Blood and tooth samples will be laboratory tested to determine if captured animals have been exposed to the ORV baits which were distributed in August. Blood serum samples of raccoons exposed to the CS baits are expected to have elevated levels of rabies antibodies. Teeth of raccoons exposed to the FMP baits should show presence of the tetracycline biomarker.

ORV PROGRAM 2002-EVALUATION

This was the first year for ORV bait distribution in Maine. Serology and tooth data is not yet available from the 2 pre-bait ORV density studies that were conducted in 2002.

SUMMARY

The summer of 2003 marked the first year of WS cooperative participation in the Maine ORV program and the second year in the national rabies program. Several Maine agencies put continuous effort into the collection of animals to be tested for rabies, investigation and testing of suspicious animals, vaccinations, and enforcement of quarantines, and public education of rabies.

The documented northward movement of the raccoon variant of rabies gives Maine an important role in preventing the spread of rabies north and east towards the Canadian border. Increased road kill and enhanced rabies surveillance should aid in determining rabies spread in Maine. The ORV program goals for 2004 are to conduct enhanced rabies surveillance, continue raccoon relative density studies, and continue participation in the national rabies program.

LITUREATURE CITED

Maine Department of Health and Environmental Testing Laboratory. 2003. Positive rabies cases in Maine 1933-2003 and notes on the history of rabies in Maine. Maine Department of Health and Environmental Testing Laboratory, Rabies Section. Augusta, Maine, USA.

Okey, C. 1971. Rabies in Maine, 1971. The Journal of the Maine Medical Association. 62,9: 228-229.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM MARYLAND 2003

BACKGROUND

Raccoon (*Procyon lotor*) rabies first entered Maryland in Allegany County in 1981. It quickly spread and is now present throughout the state. Raccoon rabies was first documented in Anne Arundel County in 1984. In 2000, Anne Arundel County reported 43 cases of animal rabies, a downward trend from the 73 reported in 1998 and 97 cases in 1997. From 1996-1998 an average of 18 cases of animal rabies was reported from the Annapolis Peninsula alone.

In October 1998, the Anne Arundel County Department of Health initiated an oral rabies vaccination (ORV) program on the Annapolis Peninsula. Fishmeal polymer (FMP) baits, containing Raboral V-RG® vaccine (MERIAL Limited, Athens, Georgia, USA), have been distributed each year on the Annapolis Peninsula since October 1998 and on Gibson Island since 2000. In 2001, the ORV project was expanded with the assistance of Wildlife Services (WS) to the Broadneck Peninsula, Anne Arundel County. Annapolis Peninsula, Gibson Island, and Broadneck Peninsula comprise 94 km², 4 km², and 88 km², respectively. This is a cooperative effort between WS and the Anne Arundel County Department of Health. Wildlife Services provides the major source of funds for project implementation.

ORV PROGRAM 2003

Bait Distribution

The 2003 ORV efforts were expanded to include all (1,080 km²) of Anne Arundel County, Maryland, except for a southern portion of the Annapolis Peninsula (Figure 1). A total of 78,807 FMP baits, containing Raboral V-RG® vaccine, were distributed in Anne Arundel County. On 25 August, 32,529 FMP baits were distributed by fixed-wing aircraft during 3 flights. From 19-22 August, 26 August, 8 September, and 21 October, 34,741 FMP baits were distributed by helicopter during 21 flights. From 18-28 August, ground teams distributed 11,537 FMP baits by hand. Cost for FMP baits was \$1.27/bait. The fixed-wing aircraft and flight crew were provided by Dynamic Aviation and the helicopter and flight crew were provided by the Anne Arundel County Police Department. Baiting efforts and support were provided by WS and the Anne Arundel County Department of Health.

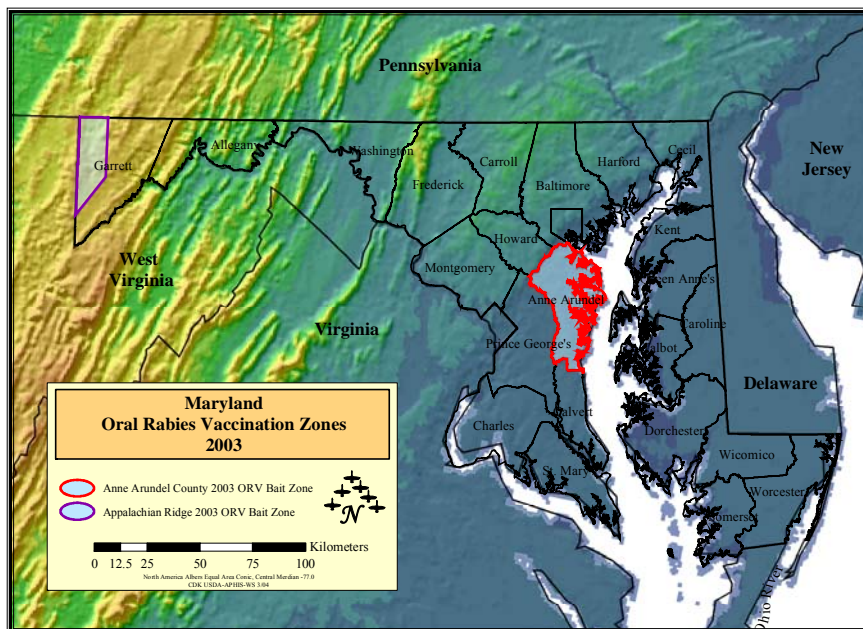


Figure 1. Oral rabies vaccination zones in Anne Arundel and Garrett Counties, Maryland, 2003.

The fall of 2003 marked the first year of the eastward expansion of the Appalachian Ridge ORV program into Maryland. From 19-23 August, WS distributed 48,071 FMP baits by fixed-wing aircraft in Garrett County (Figure 1). On 5 September, ground teams distributed an additional 360 FMP baits by hand. Baiting efforts and support were provided by WS and the Garrett County Department of Health.

POPULATION MONITORING

From 22 July-1 August 2003, WS conducted a raccoon relative density study in the Hanover area of Anne Arundel County (Table 1). All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Table 1. Results of relative density (raccoon/km²) trapping efforts in Anne Arundel County, Maryland, 2003.

	Density study (pre-bait)
Trap nights	500
Unique raccoons	27
Recaptured raccoons	8
Total raccoons	35
Trap success ^a	5.4%
Relative density	9

^aunique raccoons

Post-bait Evaluation

On 22 September 2003, WS initiated post-bait ORV raccoon live trapping to collect blood and tooth samples to evaluate and monitor program success in Anne Arundel County (Table 2).

Table 2. Results of post-bait ORV surveillance trapping efforts in Anne Arundel County, Maryland, 2003.

	Post-bait
Trap nights	1,075
Unique raccoons	133
Recaptured raccoons	18
Total raccoons	151
Trap success ^a	12.4%

^aunique raccoons

Levels of rabies virus neutralizing antibodies in relative density and post-bait ORV live-trapped raccoons will be used to help determine the effectiveness of current ORV baiting in Anne Arundel County. The location of recaptures will also aid in determining home range size/movement patterns of the raccoons within the study areas.

Non-target Captures

Fifty five non-target animals were captured and released in 2003, which included: 15 feral cats (*Felis catus*), 2 red fox (*Vulpes vulpes*), 37 opossums (*Didelphis virginiana*), and 1 woodchuck (*Marmota monax*).

ORV PROGRAM 2002-EVALUATION

On 23 September 2002, 15 October 2002, and 4 November 2002, WS initiated post-bait ORV raccoon live trapping to collect blood serum, teeth, and other biological data to evaluate and monitor program success on the Annapolis Peninsula, the Broadneck Peninsula, and Gibson Island (Table 3).

In June 2002, at the request of the Anne Arundel County Department of Health, WS conducted ORV raccoon live trapping to collect biological samples from an area immediately beyond the southern boundary (South River) of the Annapolis Peninsula ORV area (Table 4). Teeth were not collected during this trapping effort.

Table 3. Oral rabies vaccination evaluation trapping efforts on the Annapolis Peninsula, Broadneck Peninsula, and Gibson Island, Anne Arundel County, Maryland, 2002.

	Annapolis Peninsula	Broadneck Peninsula	Gibson Island
Trap nights	318	458	122
Unique raccoons	52	55	38
Recaptured raccoons	2	9	2
Total raccoons	54	64	40
Trap success ^a	16.4%	12.0%	31.1%
Positive rabies antibody response ^b	46.0%	36.0%	18.0%
Tetracycline presence	21.4%	10.3%	0.8%

^aunique raccoons

^bCenters for Disease Control and Prevention (CDC) serum dilution ≥ 5

Table 4. Oral rabies vaccination evaluation trapping efforts on the South River study area in Anne Arundel County, Maryland, 2002.

	South River
Trap nights	329
Unique raccoons	58
Recaptured raccoons	8
Total raccoons	66
Trap success ^a	17.6%
Positive rabies antibody response ^b	7.0%

^aunique raccoons

^bCDC serum dilution ≥ 5

SUMMARY

The fall of 2003 marked the first year of the eastward expansion of the Appalachian Ridge ORV program in Maryland, where WS distributed 48,071 FMP baits. The fall of 2003 also marked the third year of WS' cooperative participation in the Anne Arundel County Department of Health ORV program. With the assistance of WS, the Anne Arundel County Department of Health ORV program expanded ORV efforts to include all 1,080 km² (417 mi²) of Anne Arundel County, where 78,807 FMP baits were distributed. To date, 141,937 FMP baits have been distributed in Anne Arundel County.

Prior to 2003, 63,130 FMP baits were distributed across 3 ORV zones in Anne Arundel County encompassing 186 km² (72 mi²). During the 3 years prior to the beginning of this program, in October 1998, an average of 19 rabid animals were reported from the Annapolis Peninsula alone. Since 1998, when the ORV program was initiated, 2 rabid raccoons have been reported from the Annapolis Peninsula, 1 in 1999 and 1 in 2003.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM MASSACHUSETTS 2003

BACKGROUND

Terrestrial wildlife rabies was first detected in a northern Massachusetts town in 1992, and subsequently spread to all counties except peninsular Barnstable (Cape Cod) and Dukes (Martha's Vineyard and Nantucket Islands) counties. Rabies remains a problem in Massachusetts. Between 1992 and the end of 2003, 2,217 raccoons (*Procyon lotor*) and 1,281 striped skunks (*Mephitis mephitis*) tested positive for rabies (2003: 79 raccoons and 84 skunks). A potentially important development is that annual rabies cases in skunks has exceeded the annual cases reported in raccoons during some years (e.g., in 2002, 85 raccoons and 141 skunks tested positive). This trend also has been noted in neighboring Rhode Island.

A Tufts University (TU) study was funded by Wildlife Services (WS) during 2003 to address genetic questions about rabies strain type in skunks within the state. The Massachusetts Department of Public Health (MDPH) continues to monitor and report on rabies specimens collected and tested, due to human or domestic animal exposure, and for rabies surveillance.

Full time assistance from WS began in 2001 and has included bait acquisition and distribution, membership on the Massachusetts State and Barnstable County Rabies Advisory Committees, surveillance trapping, and small-scale studies including relative density estimation and technique trials. Major cooperators in the Cape Cod Oral Rabies Vaccination program (CCORV) include university, state, county, and local governments and organizations that provide logistical support, planning direction, funding, or facilities; they include: TU School of Veterinary Medicine, MDPH, BCDHE, Massachusetts Division of Fisheries and Wildlife, Massachusetts Division of Recreation and Conservation (State Parks/Forests, and Metropolitan District Commission), Massachusetts Department of Food and Agriculture, Massachusetts State Police Air Wing, Massachusetts Metropolitan District Commission, and Senior Environmental Corps

ORV PROGRAM 2003

Bait distribution

Wildlife Services continues to support the CCORV in southeastern Massachusetts. This WS, TU, MDPH, and Barnstable County Department of Health and the Environment (BCDHE) cooperative project (1994-present) is designed to reduce the incidence of terrestrial rabies in a 420-712 km² area directly adjacent to the Cape Cod Canal (Figure 1) in order to prevent the spread of rabies onto Cape Cod, a heavily populated tourist destination south of Boston.

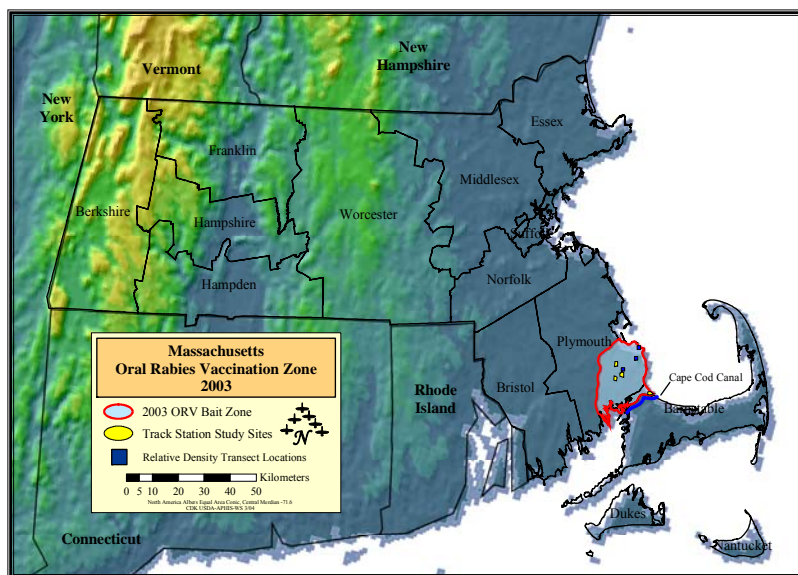


Figure 1. Oral rabies vaccination zone and study sites in Southeastern Massachusetts, 2003.

During 2003, WS assisted with TU vehicle and helicopter-based distribution of 54,822 fishmeal polymer baits, containing Raboral V-RG® vaccine (MERIAL Limited, Athens, Georgia, USA), during 4 baiting episodes over the 712 km² CCORV zone (Figure 1).

Surveillance

During 2003, WS collected 4 raccoons, 1 skunk, and 1 coyote (*Canis latrans*) from Massachusetts roads as rabies enhanced surveillance specimens. Mandibles or teeth were removed for aging and tetracycline biomarker detection, specimens were sexed, weighed, assessed for reproductive status, and screened for rabies lab-quality. Those with intact craniums, that were not badly decomposed, were frozen for submission to the MDPH, Laboratory Institute. A recent agreement between WS and MDPH, Laboratory Institute will result in the testing of all future surveillance specimens, including those in storage.

Post-bait Evaluation

Wildlife Services conducted post-bait ORV trapping and trapping as part of 2 small-scale, WS studies during August-December. Serum samples, age, sex, reproductive condition, and weight were collected from captured unique raccoons and skunks (Table 2). All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Table 2. Rabies vector sample age/sex structure data^a for the CCORV program in Southeastern Massachusetts, 2003.

	Adult	Subadult/YOY ^b
Unique raccoons (n^c=45)		
Female	18 (40.0%)	10 (22.2%)
Male	17 (37.7%)	0 (0.0%)
Unique skunks (n=14)		
Female	4 (28.5%)	0 (0.0%)
Male	6 (42.8%)	4 (28.5%)

^aWS data only

^byoung-of-year (<1 year of age)

^cnumber

Non-target Captures

Non-target species captured and released during 2003 included: 3 gray foxes (*Urocyon cinereoargenteus*), 1 red squirrel (*Tamiasciurus hudsonicus*), 1 ringed-neck pheasant (*Phasianus colchicus*), 6 feral cats (*Felis cattus*), and 9 opossums (*Didelphis virginiana*).

DEVELOPING METHODS

The WS National Rabies Management Team has requested, that in addition to assisting with CCORV barrier maintenance, MA/CT/RI WS ORV resources be used for small-scale ORV-related studies. Of primary concern is raccoon use coastal pine-oak forests that characterize southeast Massachusetts. Information from these studies may be applicable to functionally equivalent habitat types elsewhere within the United States and could be a key to developing cost-effective Phase II strategies for eliminating raccoon rabies in enzootic areas along the eastern seaboard.

Comparison of two track station types for assessing rabies vector populations in southeast Massachusetts

Pitch pine (*Pinus rigida*)/scrub oak (*Quercus ilicifolia*) communities dominate much of the current CCORV zone, and the area under ORV protection (peninsular Cape Cod). To build on relative density estimation work conducted here by WS in 2001, WS initiated a long-term track-based density index study (2002-2003) to further assess raccoon use of this habitat type and to test passive and scented track station effectiveness. Results vary by species and season (Figure 2), but the relationship between track station results and density has yet to be determined. Results of this study could increase cost effectiveness of ORV programs through reduced bait densities in this habitat type in Massachusetts and elsewhere.

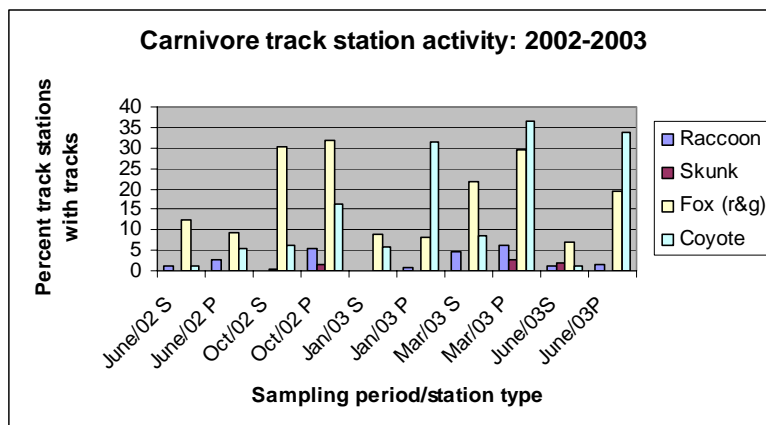


Figure 2. Carnivore track station activity in southeastern Massachusetts, 2002-2003. June 2002 n = 72 scented and 74 passive; Oct. 2002 = 174 and 195, Jan 2003 = 122 and 124, March 2003 = 129 and 112, June 2003 = 98 and 119.

Comparative raccoon/skunk relative density indices for three common Southeastern Massachusetts habitat types

An intensive, 10-day raccoon relative density indexing effort was conducted within 3 habitat types (pitch pine/scrub oak, mixed use/cover, and coastal/suburban) common to Southeast Massachusetts. During a 10-night sampling period 10 traps/habitat type were set over linear transects (4-6 km) and baited with both marshmallow/anise oil and sardines in soybean oil (Figure 3). Traps were checked daily, and moved after 3-5 days of inactivity. Raccoon and skunk blood serum samples, teeth, and physical data were collected. Numbered ear tags were affixed to both ears. Trap (and capture) locations were recorded by global position system (GPS) units. Percent capture of raccoons and skunks was highest in the coastal/suburban habitat type (71% and 62%, raccoon and skunk, respectively). Far fewer were captured in the mixed habitat type (26% and 25%, raccoon and skunk, respectively), and even less (3% and 12%, raccoon and skunk, respectively) in the pitch pine/scrub oak type (Figure 3).

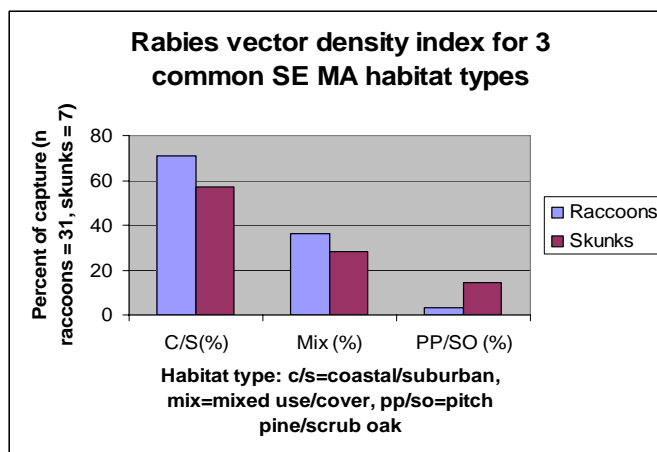


Figure 3. Comparative raccoon/skunk relative density indices for 3 common Southeastern Massachusetts habitat types. Trap nights: n = 74 C/S, 88 Mix, 93 PP (trap closure = 1/2 trap night). Raccoon n = 31 and skunk n = 8.

Pilot study: comparison of passive track station and live-trapping as methods for raccoon relative density population assessment

The WS ORV project continued with efforts to compare raccoon relative density indexing strategies for pitch pine/scrub oak forests in the CCORV zone, by conducting an 8-night track station/trapping project from 11-20 November 2003. The purpose of this effort was to: (1) compare trap and track station catch/unit effort; (2) assess the potential for autocorrelation of track station results, when track stations are located in linear clusters; (3) use of automatic cameras to assess track station error related to substrate type and animal behavior; and (4) assess variability in track quality, based on substrate types. Passive track stations (n = 45-50) and live-capture cage traps (n = 45-50) were located randomly in 5 trap/track station clusters, within 3 complete blocks, selected for uniformity of habitat type and human traffic volume on Myles Standish State Forest. Each block contained 3-4 clusters of both treatment types.

Track station results included 15 raccoon, 77 fox, 184 coyote, and 2 skunk intrusion events (Figure 4). White-tailed deer (*Odocoileus virginianus*), domestic dog (*Canis familiaris*), feral cat (*Felis cattus*), rabbit, bird, and human track station intrusions also were also recorded. Track station substrate types were categorized and GPS locations recorded. Track station intrusions, where species were in doubt, were not included in the above totals.

Two unique raccoons were captured (1 recaptured) (Figure 4). Raccoon blood serum samples, teeth, and physical data were collected, and numbered ear tags were affixed to both ears. Trap (and capture) locations were recorded by GPS. A low raccoon capture rate is consistent with previous trapping experience in pitch pine/scrub oak habitat and additional sampling efforts will be made to increase sample size. Data on substrates and linear bias in track station results are not yet analyzed. Camera deployment was postponed until 2004 due to logistical constraints.

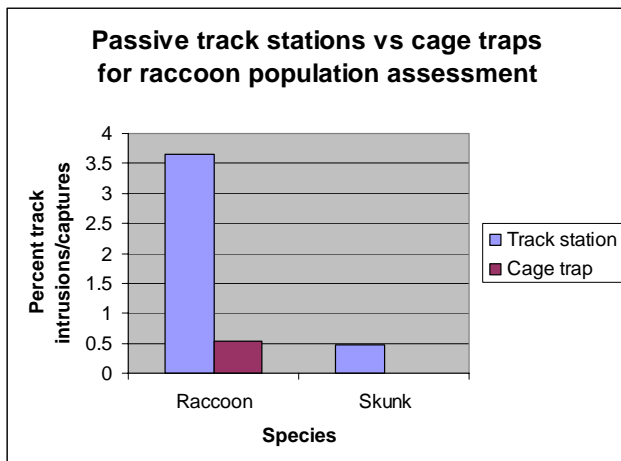


Figure 4. Pilot study to compare raccoon relative density population assessment results from track stations and trapping in Southeastern Massachusetts. Track station nights n = 409, trap n = 377.

2004 PROJECT/WORK PLANS

Upcoming events and ORV program changes include: (1) bait distribution strategy changes based on review of historical baiting strategies and rabies surveillance data; (2) increased helicopter assistance from the Massachusetts State Police, for aerial bait distribution; (3) a continuing role for WS in contingency planning for Massachusetts wildlife rabies control efforts state-wide; (4) continuation of raccoon habitat preference research; and (5) implementation of a small-scale study to investigate bait delivery strategy improvements in relation to the unique ORV landscape of Southeastern Massachusetts.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM MISSISSIPPI 2003

BACKGROUND

Raccoon (*Procyon lotor*) strain rabies has never been documented in Mississippi. Rabies was first detected in bats (Order *Chiroptera*) within Mississippi in 1964. The last indigenous case of rabies in a dog (*Canis familiaris*) occurred in 1961. In 1965, 2 puppies imported from another state were positive for rabies, but were identified with the virus before they came into contact with other animals. Since World War II, 13 cases of human rabies have occurred in the state, the last in 1953. Most of these cases are suspected to have been canine rabies (Dr. Brigid Elchos, Mississippi Department of Health, personal communication) and occurred throughout the state. Extensive rabies vaccination programs for dogs have been conducted over the last several decades. As the number of dogs vaccinated against rabies increased, the number of positive specimens found by the Mississippi Public Health Laboratory decreased. Currently, only bat (order *Chiroptera*) strain rabies is considered enzootic within Mississippi (Riecken, W. E. Jr. 1984). The nearest known incident of raccoon strain rabies to Mississippi occurred to the east in Mobile, Alabama.

ORV PROGRAM 2003

In 2003, Wildlife Services' (WS) emphasis in Mississippi was road kill surveillance of raccoons, coyotes (*C. latrans*), red foxes (*Vulpes vulpes*), gray foxes (*Urocyon cinereoargenteus*), and striped skunks (*Mephitis mephitis*) in the counties of Hancock, Harrison, and Jackson (Figure 1). A temporary employee was hired for collection of animals. Training on brainstem removal was conducted by the Centers for Disease Control and Prevention (CDC). Training was held at the United States Fish and Wildlife Service, Mississippi Sandhill Crane National Wildlife Refuge (NWR) and was attended by WS employees and employees from the Mississippi Department of Health (MDH). The MDH has been testing all samples out of their laboratory facility in Jackson, MS. Wildlife Services has recruited information on sick animals from county officials, Wildlife Law Enforcement officers, and city animal control officers. An article of our activities appeared in the Sun Herald, which is the official newspaper along the Mississippi Gulf Coast. We also have tied into the 1-800 number, established in Alabama for reporting sick animals. Equipment was purchased for the lab in Jackson as well as supplies for collection of specimens in the field.

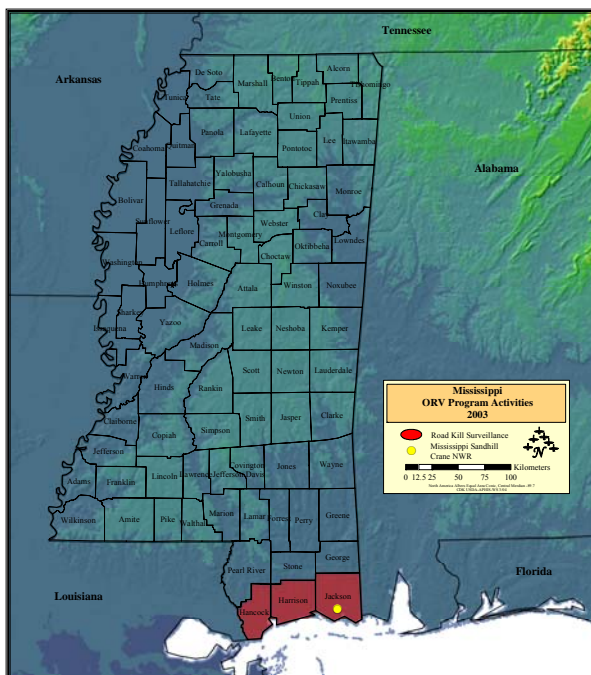


Figure 1. Location of ORV program activities in Mississippi, 2003.

Surveillance

Raccoon rabies has not been detected in Mississippi. Due to the proximity of positive cases in Mobile, Alabama, enhanced surveillance has been concentrated along the Mississippi Gulf Coast, in the counties of Jackson, Harrison, and Hancock (Figure 1). Surveillance has been by road survey to collect road-killed animals, or by cooperators and private citizens calling in complaints about sick or problem animals. In 2003, 83 animals were collected and tested. Results were negative on all animals. Animals currently being removed on a separate project, conducted on the Mississippi Sandhill Crane NWR, also have been submitted for testing (Figure 1). All test results have been negative for rabies.

Teeth were collected for all animals. Serology work for rabies neutralizing antibodies is not available for this report. All animals collected in 2003 were handled according to the American Veterinary Medical Association guidelines.

SUMMARY

The year 2003 was the first year WS has conducted enhanced rabies surveillance activities in Mississippi. Activity has been concentrated along the Mississippi Gulf Coast, in the counties of Jackson, Harrison, and Hancock. Collections began in March 2003. Eighty three animals were collected and tested. Results were negative on all animals.

LITERATURE CITED

Riecken, W. E. Jr. 1984. Review of rabies in Mississippi. Mississippi morbidity report, June, 1984. Mississippi Department of Health. 2,11:1-3.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM NEW HAMPSHIRE 2003

BACKGROUND

The first case of raccoon (*Procyon lotor*) rabies confirmed in New Hampshire was a bit of an anomaly. In March of 1992, a raccoon entered a local police officer's house in Rumney and began fighting with the family Doberman. The officer was forced to shoot the raccoon under the kitchen table. The raccoon, likely to be a "pet" of unknown origin, was brought to a local veterinarian's office and was found to be wearing 2 flea collars. Rumney is approximately 128 km (80 miles) north of the New Hampshire-Massachusetts state border and officials believed the family caring for the raccoon translocated it from a rabies-infected area in southern New England. Fortunately, no additional cases were detected in that area, but raccoon rabies did enter New Hampshire in the fall of 1992, as an extension of the epizootic in southern New England. Once in New Hampshire, rabies continued its northward spread at a rate of about 40 km (25 miles) a year. Raccoon rabies has been confirmed in all 10 counties, with the northernmost case occurring in Lancaster approximately 64 km (40 miles) south of the United States-Canada border.

Just months after the Lancaster, New Hampshire case was documented, a rabid raccoon was confirmed in Lunenburg, Vermont immediately across the Connecticut River (state border) from Lancaster. This prompted concern over the spread of rabies through the Connecticut River valley in northern New Hampshire and Vermont into Canada. In August 2001, an oral rabies vaccination (ORV) program was initiated in New Hampshire. The goal was to prevent the northward spread of the raccoon variant of the rabies virus. Through aerial and hand bait distribution, nearly 54,000 fishmeal polymer (FMP) and fishmeal-coated sachet (CS) baits containing Raboral V-RG® vaccine (MERIAL Limited, Athens, Georgia, USA) have been distributed over northern New Hampshire since 2001. Wildlife Services (WS) costs, associated with ORV program activities, in Fiscal Year 2003 totaled \$114,126 (Table 1).

Table 1. Oral rabies vaccination program costs in New Hampshire, Fiscal Year 2003.

Item	Cost
Baits ^a	\$56,000
Salaries	\$24,132
Other (equipment, travel, etc.)	\$33,994
Total	\$114,126

^afunding given to Cornell University for purchase of 56,000 baits

The New Hampshire ORV program has been a cooperative effort lead by Cornell University (CU). Wildlife Services has been the major source of federal funds for project implementation. Wildlife Services has also provided federal wildlife management leadership by continuing to play an active role in: project planning and coordination; organizing ground support for the bait drop; working in and navigating aircraft to distribute baits; coordinating the hand distribution of baits in areas too populated to bait by air; and providing surveillance and follow-up field work by collecting blood and tooth samples from live-trapped and suspect-rabid animals within the New Hampshire ORV bait zone to test program efficacy.

ORV PROGRAM 2003

Bait Distribution

In 2003, New Hampshire baiting activities took place during the Vermont ORV bait drop. During 1 flight, 18,000 CS baits were distributed by Twin Otter fixed-wing aircraft on 27 August, while 140 FMP baits were distributed by hand in the village of Colebrook, New Hampshire on 2 September (Figure 1). Total number of baits distributed in New Hampshire during the 2003 field season was 18,140. Baits were distributed over a 385 km² (149 mi²) area. Coated sachet and FMP baits cost \$1.00/bait and \$1.27/bait, respectively. Aircraft and flight crew for the 2003 ORV bait drop were provided by the Ontario Ministry of Natural Resources. Ground and baiting support was also provided by WS, CU, and the Vermont Department of Health.

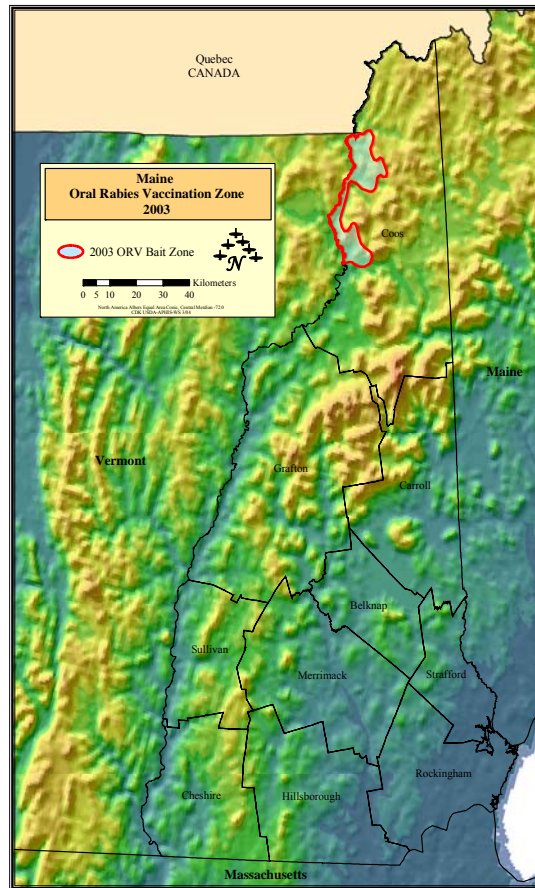


Figure 1. Oral rabies vaccination zone in New Hampshire, 2003.

ORV PROGRAM 2002-EVALUATION

In 2001-2002, WS led the evaluation phase of the New Hampshire ORV program by live-trapping and processing raccoons. Blood and tooth samples are generally taken from each live-trapped raccoon; the animal is weighed, marked with a small ear tag, and released back into the wild at the point of capture. Blood serum is later analyzed to detect rabies neutralizing antibodies (or rabies vaccination levels) and the tooth is analyzed to determine age and potential bait uptake of the animal. Fishmeal polymer baits contain a biomarker (tetracycline) that can be detected under microscope and indicates whether a raccoon consumed at least the outer portion of the bait. However, presence of tetracycline does not confirm that the vaccine sachet has been punctured or consumed. Coated sachet baits do not contain this biomarker.

Serology results that are reported from the New York State Department of Health (NYSDH) lab are represented in International Units (IU). This is different than what has been previously reported by the Centers for Disease Control and Prevention (serum dilution <5 and ≥ 5), which conducts serologic analysis for many states in the cooperative ORV program.

Blood and tooth samples were collected from the 12 raccoons captured during 2001 and 2002 relative density studies. During both years, these samples were taken prior to ORV baiting activities and represent baseline age, serology, and biomarker data (Table 2 and Table 3).

Table 2. Serology results of raccoon biological samples collected prior to ORV activities in New Hampshire, 2001-2002.

	2001	2002
Unique raccoons captured	7	5
Testable blood samples	7	5
Sero-reactive ^a	0	0
Sero-positive ^b	0	0

^aNYSDH serum titer ≥ 0.125 IU

^bNYSDH serum titer ≥ 0.5 IU

Table 3. Tetracycline biomarker results of raccoon biological samples collected prior to ORV activities in New Hampshire, 2001-2002.

	2001	2002
Unique raccoons captured	7	5
Testable tooth samples	7	5
Total presence of tetracycline biomarker	1 (22.6%) ^a	0
Year of detection:		
Year of detection unknown	1 (57.1%)	0

^aarea in which raccoon caught was never previously baited

SUMMARY

The summer of 2003 marked the third year of WS cooperative participation in the New Hampshire ORV program. The New Hampshire program is an integral part of a larger Northeastern cooperative effort (that in 2003 included: New York; Vermont; Maine; and Quebec and Ontario, Canada), which in turn, is tied to national planning efforts to contain the raccoon strain of rabies and explore strategies to eliminate this unique strain of the rabies virus.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM NEW JERSEY 2003

BACKGROUND

In the earlier part of the twentieth century New Jersey had a significant problem with rabies in dogs (*Canis familiaris*); in 1939, 675 dogs and 4 humans died of rabies in the state. In 1942, a rabies program, consisting of mass vaccination of dogs and pick-up of stray animals was initiated. As a result of these efforts New Jersey experienced its last case of canine rabies in 1956. In 1960, the first case of bat (Order *Chiroptera*) rabies was discovered in New Jersey.

The raccoon (*Procyon lotor*) rabies epizootic spread to New Jersey through Warren and Hunterdon counties in 1989. Between 1989 and 2003, 4,738 animals have tested positive for rabies in the state. Of these, 3,408 (71.9%) were raccoons. In 2003, 186 animals were confirmed with rabies and of those, 131 (70.4%) were raccoons.

CAPE MAY COUNTY ORV PROGRAM 2003

During 1991-1994, the New Jersey Division of Fish and Wildlife (NJDFW) worked cooperatively with the Cape May County Department of Health (CMDH) and the New Jersey Department of Health to conduct an experimental rabies oral rabies vaccination (ORV) program in Cape May County, New Jersey. To date, approximately 180,000 fishmeal polymer (FMP) baits, containing Raboral V-RG® vaccine (Merial Limited, Athens, Georgia, USA) have been distributed, at a rate of 64 baits/km².

Bait Distribution

Since 1995, CMDH has continued on with the ORV program (Henry Heacock, CMDH, personal communication). In 2003, the ORV bait zone in Cape May County encompassed 556 km² (Figure 1). From 1-10 October 37,000 FMP baits were distributed by helicopter and 1,000 FMP baits were distributed by hand.

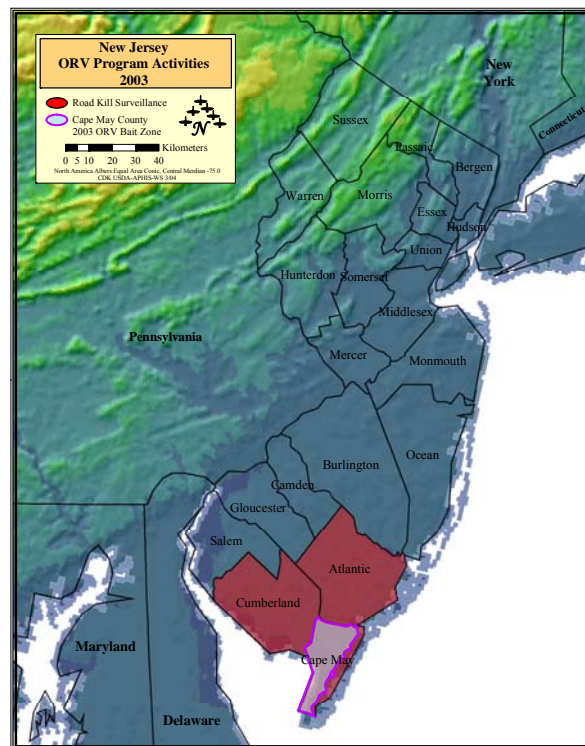


Figure 1. Oral rabies vaccination zone and surveillance activities in New Jersey, 2003.

Surveillance

Since CMDHs program had become operational there had been no enhanced surveillance to determine the effectiveness of the ORV program. In 2002, the NJDFW proposed to coordinate a program to test raccoons for rabies and determine the effectiveness of the Cape May ORV program. The purpose of the enhanced surveillance was to compare rabies occurrence in the raccoon population in Cape May County, with its occurrence in the 2 adjacent counties (Atlantic and Cumberland). Wildlife Services assisted the NJDFW with surveillance by collecting road-killed raccoons in the Cape May, Atlantic, and Cumberland counties (Figure 1).

In 2002, 8 raccoons were collected in Cape May County and in 2003, 5, 1, and 2 raccoons were collected; Cape May, Cumberland, and Atlantic Counties, respectively. All raccoons were submitted to the NJDFW Pathology lab for rabies testing. Two additional raccoons, that were trapped during other WS projects, within the ORV zone, also were submitted for rabies testing. All animals submitted tested negative for rabies. All animals collected in 2003 were handled according to the American Veterinary Medical Association guidelines.

SUMMARY

During 2002 and 2003, WS assisted in ORV enhanced surveillance in New Jersey through a partnership with the NJDFW. Sixteen road-killed raccoons were collected and submitted for testing. Although Cape May County had 3 cases of rabies in Dennis Township in 2001, there were no reported cases from 1998-2000 or from 2002-2003.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM NEW YORK 2003

BACKGROUND

Rabies remains one of the most important zoonoses in the United States. In the past decade, wildlife rabies has reached historically high levels with a subsequent increase in human rabies post-exposure prophylaxis (PEP). An outbreak that began in the late 1970s, in the Mid-Atlantic States, was attributed to translocation of infected raccoons (*Procyon lotor*) from Florida for use by various hunting clubs. This event is thought to have marked the beginning of the raccoon rabies outbreak that has aggressively spread throughout Mid-Atlantic and Northeastern United States.

Raccoon rabies first entered New York in 1990. The disease quickly spread and now is present throughout most of the state. Raccoon rabies was first documented in St. Lawrence County in 1997 and in the following year an epizootic was identified in the county with 148 confirmed wildlife cases. The outbreak continued to spread in 1999, resulting in 139 cases.

Following the epizootic in 1998, an intensive oral rabies vaccination (ORV) program was initiated in St. Lawrence County in an attempt to prevent further northward spread of the disease through New York and into Canada. The ORV program in northern New York has expanded since 1998 and currently encompasses Jefferson County and the northern portions of St. Lawrence, Oswego, and Lewis Counties, as well as the western portion of Franklin County. The 2003 bait zone comprises roughly 12,848 km² (4,900 mi²) (Figure 1). The bait zone is bounded by the St. Lawrence River to the North, Lake Ontario to the West, the Tug Hill Plateau to the South, and the Adirondack Mountains to the East.

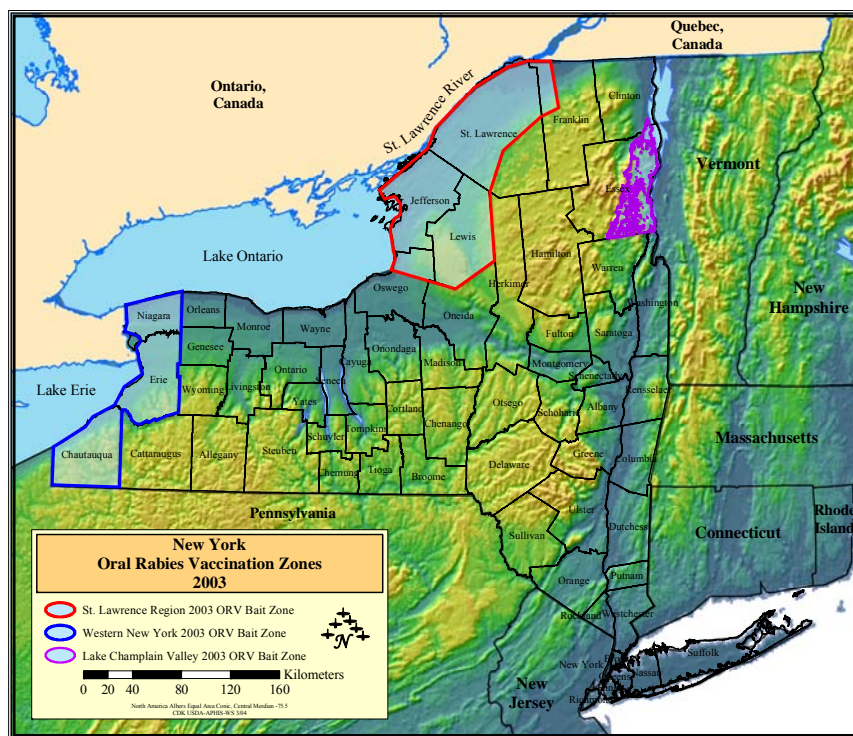


Figure 1. Oral rabies vaccination zones in the St. Lawrence Region, Lake Champlain Valley Region, and western New York, 2003. (Lake Champlain Valley data used with permission from the New York State Department of Health)

In addition to the ORV zone in northern New York, 6,919 km² (2,668 mi²) were baited in Niagara, Erie, and Chautauqua Counties, in western New York and 1,861 km² (717 mi²) were baited in the Lake Champlain Valley region of Essex and Clinton Counties. Cornell University is the lead coordinating agency for the northern and western ORV zones, with Wildlife Services (WS) as an active participant, providing major cooperative funding and federal wildlife management leadership. In the Lake Champlain Valley Region, the New York State Department of Health (NYSDH) Zoonoses Program is the lead agency.

ORV PROGRAM 2003

The goal of the ORV program is to achieve sufficient levels of immunity in the raccoon population to create a barrier against the spread of raccoon rabies virus to new, uninfected areas.

Bait Distribution

Aerial baiting in the St. Lawrence Region occurred from 27 August-1 September 2003. Two types of baits, containing Raboral V-RG® vaccine (MERIAL Limited, Athens, Georgia, USA), were distributed as part of the 2003 ORV program. In the St. Lawrence Region, 711,292 coated sachet (CS) baits and 116,160 fishmeal polymer (FMP) baits were distributed over 12,848 km². In western New York, 397,162 CS baits and 47,037 FMP baits were distributed, over 6,809 km², from 1-2 September 2003 and 30 September-5 October 2003. In the Lake Champlain Valley Region 133,000 FMP baits were distributed, over 1,774 km², from 10-22 August 2003 (Figure 1).

Coated sachet and FMP baits cost \$1.00/bait and \$1.27/bait, respectively. Aircraft and flight crew for the 2003 ORV program in the St. Lawrence Region and in western New York were provided by the Ontario Ministry of Natural Resources and New York State Police Aviation Unit. Aircraft and flight crew for the 2003 ORV program in the Lake Champlain Valley Region also were provided by the New York State Police Aviation Unit. Ground and baiting support was provided by WS; Cornell University; state, county, and local government agencies; and many public volunteers.

Population Monitoring

In a coordinated effort to monitor raccoon populations, 6 relative density studies have been completed in New York since 1999. These studies have been conducted to help document raccoon population density trends in areas of agricultural habitat, areas of higher elevations in the foothills of the Adirondack Mountains, and in areas of preferred raccoon habitat along the St. Lawrence River that may not be easily baited by aircraft. Relative densities varied with habitat and ranged from highs of ≥ 45 raccoon/km² in preferred habitats, to low or absent raccoon populations in poorer habitats of the Adirondack Mountains (Table 1). All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Table 1. Estimated relative density indices (raccoon/km²) of raccoon populations in the St. Lawrence Region of New York, 1999-2003.

Year	Location	Elevation (m)	Density index
1999	Louisville (agriculture)	75	9
1999	Colton (foothills)	450	2
2000	Clifton (mountains)	470	0
2000	Colton (river corridor mountain)	450	2
2001	Hammond (St. Lawrence River shoreline)	100	11
2003	Massena, Barnhart Is. (St. Lawrence River)	100	45

Post-bait Evaluation

St. Lawrence Region.--On 22 September 2003, WS initiated post-bait ORV live trapping to collect blood serum and tooth samples, as well as other biological data, to evaluate and monitor project success (Table 2).

Table 2. Post-bait ORV raccoon surveillance trapping efforts in the St. Lawrence Region of New York, 2003.

	Bait type	
	CS	FMP
Trap nights	1,288	293
Unique raccoons	187	126
Recaptured raccoons	59	10
Total raccoons	246	136
Trap success ^a	15%	46%
Mean elevation	100m	125m

^aunique raccoons

Since raccoon rabies became established in the Mid-Atlantic region in the late 1970s, it has spread to new areas at approximately 24-29 km/year. Rabies appears to spread rapidly through wildlife populations existing in preferred raccoon habitats. Major physiographic barriers, such as rivers and mountain ranges, may potentially impede the spread of rabies. The St. Lawrence River may act as a physical barrier, impeding the northward movement of rabies. In addition, high mountain elevations with contiguous forest, such as those in the Adirondack and Appalachian Mountains, may support low raccoon densities and also act as barriers to the spread of the rabies virus.

St. Lawrence River Shoreline Study.--The inability to aerially distribute baits at prescribed densities along river shorelines, in conjunction with raccoon fidelity for developed shoreline habitat, where food is abundant, could possibly result in a significantly under-vaccinated subset of the local raccoon population. These under-vaccinated areas may represent corridors through which raccoon rabies could spread. This could compromise larger ORV efforts because raccoons have been documented crossing major rivers. For example, animals ear tagged in Canada by the OMNR, have been captured in New York by WS staff.

In 2001, WS initiated a multi-year study to assess aerial ORV baiting efficacy along the St. Lawrence River shoreline. Steep topography, numerous small islands, a highly developed shoreline, and a State highway paralleling the river typify the study area, posing challenges for distributing baits to targeted raccoon habitat. In order to avoid a significant loss of baits in the river and striking clustered shoreline houses and residents with baits, baiting machines are turned off as ORV aircraft approach the shoreline.

On 29 September, WS began post-bait ORV trapping of raccoons on a 12 km² area along the St. Lawrence River to collect blood serum and tooth samples, as well as other biological data, to evaluate and monitor program success (Table 3). Serology levels of pre-bait ORV samples, collected in 2001 and 2002, will be compared to serology levels in post-bait ORV samples, collected in 2001-2003. Information collected will be used to identify the percentage of the raccoon population in the study areas with detectable levels of rabies virus neutralizing antibodies and to assess the impact of hand baiting to augment aerial bait distribution. The results of this study may have broader applicability to national ORV projects given the potential common problem of distributing baits close to shorelines because of dwellings and human activity.

Table 3. Pre- and post-bait ORV trapping results, St. Lawrence River Shoreline Study, 2001-2003.

	Pre-bait		Post-bait		
	2001	2002	2001	2002	2003
Trap nights	1,448 ^a	980	684	731	721
Unique raccoons	101	58	32	75	80
Recaptured raccoons	85	78	16	32	26
Total raccoons	186	136	48	107	106
Trap success ^b	7.0%	5.9%	4.7%	10.3%	11%

^aincludes Hammond Density study area

^bunique raccoons

Lake Champlain Valley Region.--Three WS Biologists assisted the NYSDH Zoonoses Program in monitoring the Lake Champlain Valley Region ORV program, by trapping raccoons and collecting blood and tooth samples for program evaluation in September 2003.

Other Rabies Activities

In addition to comparing raccoon pre- and post-bait ORV serology levels, radio telemetry was used to monitor seasonal raccoon movement patterns. Thirteen adult raccoons (6 males, 7 females) were live trapped, sampled for pre-bait ORV serology levels, and fitted with radio collars (Advanced Telemetry Systems, Isanti, Minnesota, USA) in July 2002. An intensive tracking and surveillance effort was initiated during the summer 2002. Tracking began shortly after sunset and continued until shortly before dawn. All animals were located approximately 50 times over a 6 week period, beginning 4 weeks prior to the bait drop to 2 weeks post-bait drop. Data collected from this study will help determine raccoon home range and whether or not movement patterns bring raccoons into contact with aerially distributed baits. Data from this study are currently being analyzed.

Winter tracking of raccoon movements was conducted from December 2002-April 2003. Radio-collared animals were monitored on a weekly basis to determine winter den site locations, den site fidelity, and winter movement patterns. Preliminary findings showed that all raccoons remained inactive throughout most of winter until the breeding season in February. Movement of male raccoons began in mid-February, followed by females approximately a week and a half later. Movement activity of both sexes peaked in mid-March. A period of inactivity, for both males and females, following the breeding season, occurred from late March to mid-April.

In June of 2003, to assess raccoon fidelity to shoreline habitat, WS initiated a study aimed at discovering how raccoons would respond to being relocated out of their home range. Three radio-collared raccoons, with home ranges defined from previous telemetry data, were moved independently 2 miles inland, away from the St. Lawrence River. Monitoring was conducted on an hourly basis, from dusk until dawn. All 3 animals returned to their respective home territories within 24-72 hours. Two additional radio-collared raccoons were relocated 6 miles from their respective territories. Both of the 6-mile, relocated raccoons returned to their home ranges. One animal returned within a week, the second in approximately a month.

Non-target Captures

Non-target animals captured and released in 2003 included: 78 striped skunks (*Mephitis mephitis*), 4 fisher (*Martes pennanti*), 5 Eastern cottontail rabbits (*Sylvilagus floridanus*), 12 feral cats (*Felis cattus*), 4 porcupines (*Erethizon dorsatum*), 1 gray squirrel (*Sciurus carolinensis*), 1 red squirrel (*Tamiasciurus hudsonicus*), and 2 opossums (*Didelphis virginiana*).

ORV PROGRAM 2002-EVALUATION

Serology results that are reported from the NYSDH lab are represented in International Units (IU). This is different than what has been previously reported by the Centers for Disease Control and Prevention (serum dilution <5 and ≥ 5), which conducts serologic analysis for many states in the cooperative ORV program.

Serology, Tetracycline Biomarker, and Age Results

St. Lawrence Region.--The goal of the ORV program is to achieve sufficient levels of immunity in the raccoon population to create a barrier against the spread of the rabies virus to new, uninfected areas. On 30 September 2002, WS initiated post-bait ORV live trapping to collect blood serum and tooth samples, as well as other biological data, to evaluate and monitor program success (Table 4).

Table 4. Serology and tetracycline biomarker results of raccoon biological samples collected during post-bait ORV program evaluation in the St. Lawrence Region, New York, 2002.

	CS	FMP
Serology		
Unique raccoons captured	94	100
Testable blood samples	87	94
Sero-reactive ^a	21 (24.1%)	16 (17.0%)
Sero-positive ^b	27 (31.0%)	13 (13.8%)

^aNYSDH serum titer 0.125-0.25 IU

^bNYSDH serum titer ≥ 0.5 IU

Lake Champlain Valley Region.--In September 2002, WS Biologists assisted the NYSDH Zoonoses Program in monitoring the Lake Champlain Valley Region ORV program, by trapping raccoons and collecting blood and tooth samples, as well as other biological data, to evaluate and monitor program success September 2002 (Table 5).

Table 5. Serology and tetracycline biomarker results of raccoon biological samples collected during post-bait ORV program evaluation in the Lake Champlain Valley Region, New York, 2002 (A. Willsey, personal communication).

	FMP
Serology	
Unique raccoons captured	75
Testable blood samples	75
Sero-reactive ^a	13 (17.3%)
Sero-positive ^c	26 (34.7%)

^aNYSDH serum titer 0.125-0.25 IU

^bNYSDH serum titer ≥ 0.5 IU

SUMMARY

Wildlife Services has cooperatively participated in the ORV program in New York for 6 years. This project is part of a larger Northeastern ORV effort that includes Vermont, New Hampshire, Maine, and Ontario, Canada, that is in turn, tied to the National ORV program to contain the raccoon strain of rabies and explore strategies to eliminate this unique variant of the rabies virus.

To date, over 3.7 million Raboral V-RG® baits have been distributed across the St. Lawrence Region, encompassing 12,848 km². Since the program was initiated in 1998, a noted decline in positive rabies cases has been recognized. Almost 150 confirmed wildlife rabies cases were reported in 1998 and again in 1999 in St. Lawrence County. In 2002, there were 4 rabies cases, only one of which was attributed to a raccoon. No additional raccoon rabies cases have been confirmed as of 11 March 2004.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM OHIO 2003

BACKGROUND

The presence of raccoon (*Procyon lotor*) strain rabies was first documented in Mahoning County, Ohio in 1996. Rabies cases continued to escalate and in April of 1997 an epizootic of raccoon-strain rabies was identified in northeastern Ohio, with 62 positive cases by year's end. With an epizootic occurring, and a peak in public interest, an oral rabies vaccination (ORV) program was initiated in Ohio in an attempt to prevent the further westward spread of raccoon strain rabies. The original baited zone in Ohio included Trumbull, Mahoning, and Columbiana Counties, which encompassed 1,780 km² (688 mi²). With increased surveillance, raccoon rabies cases were identified outside the ORV bait zone. Subsequently, in the fall of 1999, the ORV bait zone in Ohio more than tripled in size to include: Ashtabula, Trumbull, Mahoning, Columbiana, Carroll, and Jefferson Counties, encompassing 6,497 km² (2,509 mi²). In 2003, the ORV program in Ohio encompassed 8,518 km² (3,289 miles²) and included Ashtabula, Trumbull, Columbiana, Mahoning, Jefferson, Carroll, Harrison, Belmont, and Monroe Counties (Figure 1). Ohio's ORV zone is part of what is now referred to as the Appalachian Ridge Barrier (ARB), which uses natural barriers (Ohio River and Lake Erie), supplemented with rabies vaccine bait distribution, to prevent the westward spread of raccoon strain rabies.

The Ohio Department of Health (ODH) is the lead agency for Ohio's ORV program. Wildlife Services (WS) is an active cooperator, now providing a major source of cooperative funding and federal wildlife management leadership. Additional cooperators include Ohio Department of Agriculture (ODA), Ohio Division of Wildlife (ODW), The Centers for Disease Control and Prevention, The Ohio State University, and local and county health departments. In a cost-share effort, the ODH afforded \$1,512,816 toward ORV program activities in 2003. Wildlife Services costs, associated with 2003 ORV program activities, totaled \$743,189 (Table 1).

Table 1. Oral rabies vaccination program costs for ODH and WS, 2003.

Item	ODH cost	WS cost
Fishmeal polymer baits	\$559,135	\$170,078
Aircraft contracts/jet fuel	\$2,010	\$99,135
Local health department grants/contracts	\$236,784	NA
Rabies lab testing	\$199,169	NA
Salaries and benefits	\$473,441	\$220,774
ORV operations (education, equipment, travel, utilities, etc.)	\$42,277	\$253,202
Total	\$1,512,816	\$743,189

ORV PROGRAM 2003

The goal of the 2003 ORV program was to: (1) achieve sufficient levels of rabies immunity in raccoon populations, (2) to create a barrier, and (3) to prevent the spread of the rabies virus to new uninfected areas.

Bait Distribution

A single baiting campaign was conducted in Ohio in 2003 from 8-17 September. During the September bait drop 536,908 fishmeal polymer (FMP) baits, containing Raboral V-RG® vaccine (Merial Limited, Athens Georgia, USA), were distributed by fixed wing aircraft (Figure 1). A total of 23,400 FMP baits were distributed by rotary aircraft (helicopter), while 57,518 FMP baits were distributed by hand. The total number of FMP baits distributed within the Ohio barrier during the 2003 baiting campaign, was 617,826 at a cost \$1.27 each. The FMP baits were distributed by air at a rate of 75 baits/km². Aircraft and flight crew for the 2003 ORV program were provided by the Ontario Ministry of Natural Resources. Ground and baiting support were provided by WS, ODH, ODW, ODA, Ohio National Guard, and local and county health departments.

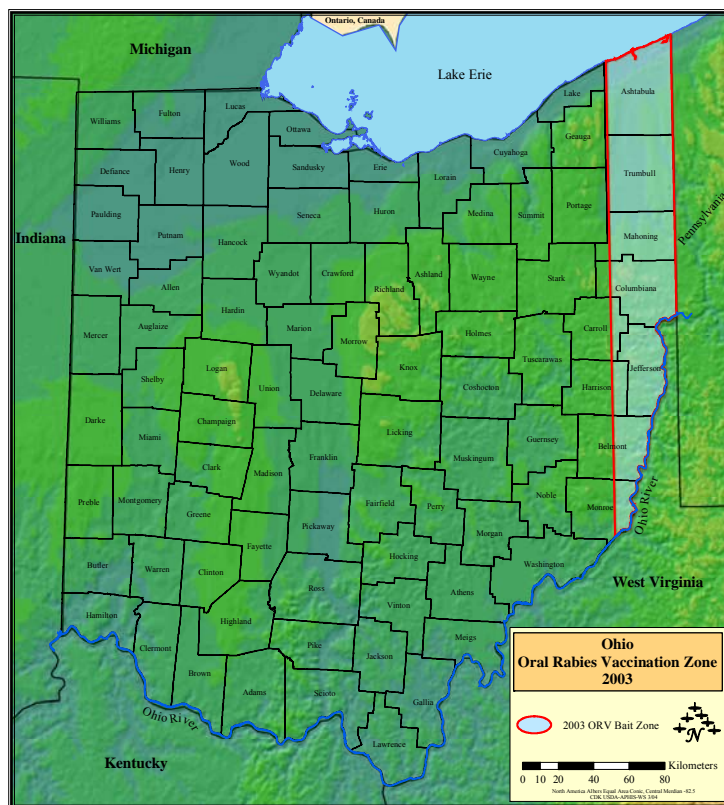


Figure 1. Oral rabies vaccination zone in Ohio, 2003.

Surveillance

Throughout 2003, WS provided enhanced surveillance activities to assist the ODH with raccoon rabies submissions for testing. During the 2003 trapping season all raccoons which appeared to have puncture wounds (bite marks), exhibited disorientation, or showed signs of illness were euthanized in accordance with the American Veterinary Medical Association (AVMA) guidelines and were submitted for testing. In addition, live wildlife that showed signs of sickness and disorientation, obtained from concerned Ohio residents, were submitted to the ODH for rabies testing.

Throughout 2003, WS conducted multiple road kill surveys in 4 eastern Ohio counties and submitted samples that were suitable for rabies testing. In addition, WS monitored “hot spot” areas, or areas of special concern in Ohio, where raccoon strain rabies persists along the borders between Ohio and Pennsylvania. Monitoring of these areas included road kill surveys, along with notifying and educating police, fire, and postal workers of the rabies threat in the area. Thirty four animals were collected by Ohio WS in 2003; all animals tested negative for rabies. Ohio WS will continue to provide enhanced surveillance in 2004.

Population Monitoring

Wildlife Services standard protocol for indexing raccoon population density was used in 2 areas within Ohio during the fall of 2003 (Table 2). The 2 areas were representative of the habitat found in southeastern Ohio (old strip mines interspersed with forested and agricultural lands). Fifty traps were placed out on each 3 km² site for 10 consecutive nights. Relative density estimates were obtained during regular fall post-bait ORV surveillance trapping. All animals trapped in 2003 were handled according to the AVMA guidelines.

Table 2. Estimated relative density indices (raccoon/km²) of raccoon populations in Jefferson County, Ohio, 2003.

Location	Habitat	Elevation (m)	Density
Jefferson County	Agriculture	300-350	8.3
Jefferson County	Agriculture	300-350	7.7

Post-bait Evaluation

During the fall of 2003, WS participated in 1 trapping campaign designed to evaluate and monitor project success. This was accomplished through collection of raccoon biological data, blood serum, and tooth samples. From 14 October-14 November 2003, WS conducted fall post-bait ORV raccoon live trapping efforts in Mahoning, Columbiana, Jefferson, Belmont, and Harrison Counties. Samples were collected from 154 raccoons, over 2,127 trap nights (Table 3).

Table 3. Fall post-bait ORV raccoon surveillance trapping efforts in Ohio, 2003.

	Fall, post-bait ORV
Trap nights	2,127
Unique raccoons	154
Recaptured raccoons	0
Total raccoons	154
Trap success ^a	7.2%
Non-target captures	37

^aunique raccoons

Other Rabies Activities

Wildlife Services trapped 154 raccoons during 2003 surveillance efforts in Ohio (Table 3). All raccoons that WS has captured and released during as a part of surveillance have been ear-tagged with a unique number. These ear tags also contain a phone number and a label which reads “reward”. Wildlife Services logged 12 ear-tag numbers from Ohio residents who collected the reward during 2003. A reward of \$20 is paid by WS for each set of ear tags submitted. In return, WS gained information on raccoon biology and movements. The majority of animals that were returned by hunters and trappers moved ≤ 1.61 km (≤ 1 mile) from the original site of capture.

In November of 2003, WS collected 41 carnivores harvested by fur trappers from within the Ohio ORV bait zone. Carnivores collected included: coyotes (*Canis latrans*), mink (*Mustela vison*), red fox (*Vulpes vulpes*), opossum, and striped skunk (*Mephitis mephitis*). Carnivores harvested by trappers in Ohio were collected for biomarker detection in teeth and jawbones. Tetracycline hydrochloride is commonly used as a biomarker to assess bait uptake in ORV programs. However, presence of tetracycline does not confirm that the vaccine sachet has been punctured or consumed. Tooth samples collected in 2003 will help to determine age structures and bait uptake rates for carnivores that come in contact with and compete for FMP baits that are being dropped via aircraft to target raccoons.

Non-target Captures

Non-target captures included: 3 fox squirrels (*Sciurus niger*), 2 released and 1 found deceased; 2 red squirrels (*Tamiasciurus hudsonicus*), 1 released and 1 found deceased; 1 striped skunk, released; 7 Eastern cottontail rabbits (*Sylvilagus floridanus*), all released; 1 woodchuck (*Marmota monax*), euthanized; and 23 opossums (*Didelphis virginiana*), all euthanized.

ORV PROGRAM 2002-EVALUATION

Serology, Tetracycline Biomarker, and Age Results

The goal of the 2002 ORV program was to achieve sufficient levels of rabies immunity in the raccoon population to create a barrier, and to prevent the spread of the rabies virus to new uninfected areas. During the summer and fall of 2002, WS participated in 2 trapping campaigns designed to evaluate and monitor project success. This was accomplished through collection of raccoon biological data, blood serum, and tooth samples. On 17 June

2002, WS initiated the summer, pre-bait ORV raccoon live trapping effort in Mahoning, Jefferson, Harrison, and Belmont counties. Samples were collected from 159 raccoons over 467 trap nights (Table 4 and Table 5).

From 9 September-30 October 2002, WS conducted fall, post-bait ORV raccoon live trapping efforts, following the late summer bait drop for the previously, twice-baited zones of Jefferson, Belmont, Monroe, and Harrison counties. Blood and tooth samples were collected from 120 raccoons over 1,129 trap nights, during the post-ORV trapping campaign (Table 4 and Figure 2).

Table 4. Serology and tetracycline biomarker results of raccoon biological samples collected during pre- and post-bait ORV evaluation in Ohio, 2002.

	Collection period	
	Summer, pre-bait ORV	Fall, post-bait ORV
Serology		
Unique raccoon captures	159	120
Testable blood samples	154	118
Positive rabies antibody response ^a	20 (12.9%)	11 (9.3%)
Tetracycline		
Unique raccoon captures	159	120
Testable tooth samples	155	120
Presence of tetracycline biomarker	22 (14.2%)	29 (24.2%)

^aCenters for Disease Control and Prevention serum dilution ≥ 5

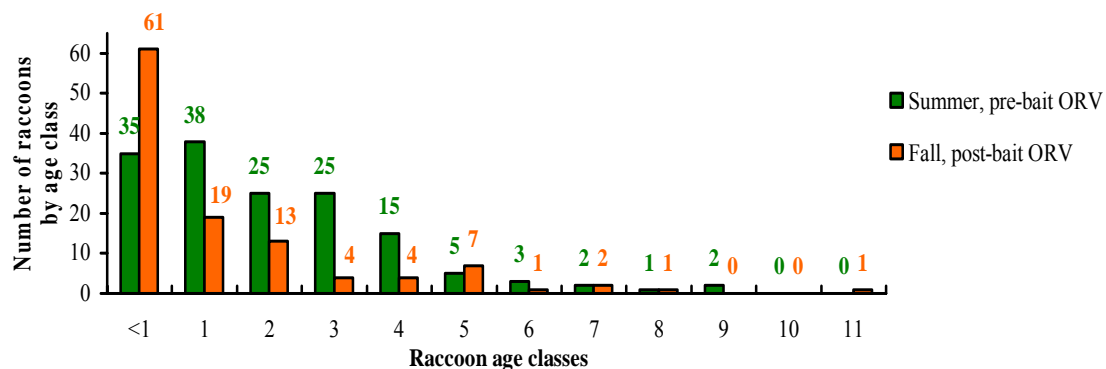


Figure 2. Age results of 264 raccoon biological samples collected during pre- and post-bait ORV evaluation in Ohio, 2002.

In fall of 2002, WS collected over 500 raccoons and carnivores harvested by fur trappers from within the Ohio ORV bait zone. Of those 500 animals, WS sent 200 raccoon canine tooth samples in for analysis. Teeth were analyzed for age; tetracycline presence, related to age; and tetracycline presence, related to time of year (summer versus fall baiting).

Age structure of the 200 raccoons sampled ranged from young-of-year (<1 year old), to 13 years of age. Age structure of the trapper-harvested sample was relatively old, with only 35% young-of-year raccoons. Hunters may select for older animals than would be obtained through random sampling. Mean number of animals found positive within an age class ranged from 27%, for animals 1 year old, to 80% for animals ≥ 3 years old. Fall versus summer presence data indicated that the acceptance/contact rate of fall baits was twice that of summer baits (Table 5).

Table 5. Number of tetracycline bait lines, counted by summer versus fall trapping, in Ohio, 2002.

Year	Summer	Fall
1997	0	5
1998	9	7
1999	6	23
2000	19	41
2001	37	73
Total	71	149

SUMMARY

The spring of 2003 marked the seventh year of WS cooperative participation in the Ohio ORV program. This program is part of a larger ORV ARB effort that includes: West Virginia, Virginia, Tennessee, Maryland, and Pennsylvania. Ohio is an integral part of a national ORV program. In 2004, the ARB will extend to include larger portions of Pennsylvania, West Virginia, Virginia, and Tennessee, and include western Maryland.

In 2004, Ohio will continue to participate in the ORV program in order to prevent the westward spread of raccoon strain rabies, as well as to achieve the goal of eliminating raccoon strain of rabies from Ohio. To date 6,030,483 FMP baits, containing rabies vaccine, have been distributed across eastern Ohio. Since program inception in 1997, there has been a noted decline in reported positive raccoon strain rabies cases in the ORV baited zone. In 1997, there were 62 positive cases, which declined to 26 positive cases in 1998. From November 1999 to October 2001, there were no detected raccoon strain rabies cases in Ohio.

On 6 November 2001, Ohio had 1 documented case of raccoon strain rabies, which was located approximately ≤ 1.61 km (≤ 1 mile) from the Ohio-Pennsylvania border. In 2003, 2 cases of raccoon strain rabies were identified, which also were located ≤ 1.61 km (≤ 1 mile) from the Ohio-Pennsylvania border. Raccoon rabies remains enzootic in Pennsylvania; therefore, it is not surprising that rabies cases occurred near the Ohio-Pennsylvania border. Pennsylvania has joined the ORV effort and has started distributing rabies vaccine bait within its borders; Ohio can now look to achieve its goal of eliminating raccoon strain of the rabies virus from the state. However, these cases are still a reminder that the continuation of ORV, supported by enhanced surveillance is necessary.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM PENNSYLVANIA 2003

BACKGROUND

Raccoon (*Procyon lotor*) rabies was first reported in Pennsylvania in 1982. The first documented cases occurred in Bedford, Fulton, and Franklin Counties. Twelve years later raccoon rabies had become enzootic throughout the Commonwealth's 67 counties. Since 1995, >350 wild animals are positively diagnosed for rabies annually. The first oral rabies vaccine (ORV) baits (i.e., fishmeal polymer [FMP], containing Raboral V-RG® vaccine [Merial, Athens, Georgia, USA]) were distributed in Pennsylvania during the fall of 2001. A total of 138,602 baits were hand-distributed across 1,875 km² within 2 counties in the northwest corner of the Commonwealth. Pennsylvania expanded its baiting program in 2002 and 2003 to cover 25,189 km² in 18 western counties bordering Maryland, Ohio, and West Virginia (Figure 1). The expanded baiting area in Pennsylvania extends the previous rabies barrier established in Ohio. The Pennsylvania Department of Agriculture (PDA) provided the state leadership for the baiting effort. The United States Department of Agriculture, Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) provided wildlife management leadership and contributed significant funding.

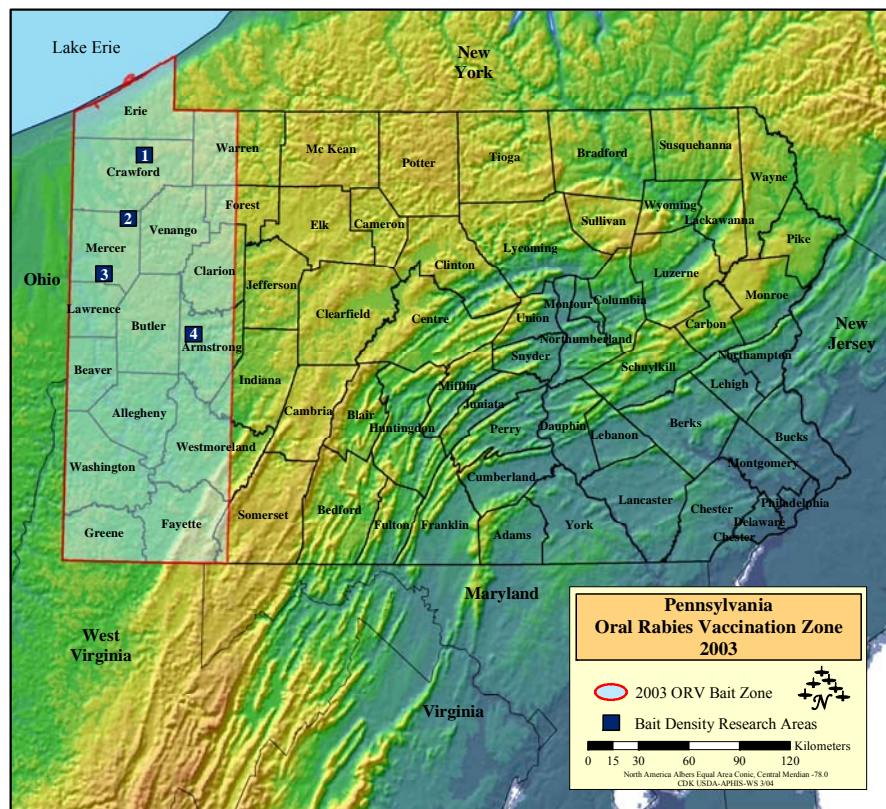


Figure 1. Oral rabies vaccination zone and location of bait density research areas in western Pennsylvania, 2003.

ORV PROGRAM 2003

The goal of the Pennsylvania ORV program is to strengthen the existing ORV barrier in eastern Ohio and to expand this barrier eastward to reduce the area where raccoon rabies occurs. This cooperative initiative will create a vaccinated area of sufficient scope and allow the exploration of methods to eliminate raccoon rabies in Pennsylvania.

Bait Distribution

Fishmeal polymer baits were used as part of the 2003 ORV program at a cost of \$1.27/bait. Large cities and towns were hand-baited from 11-20 August 2003; 288,882 baits were distributed. Personnel for the following agencies participated in hand baiting: PDA; Pennsylvania Department of Health (PDOH); Erie County Department of Health; Allegheny County Health Department; Pennsylvania Department of Conservation and Natural Resources (DCNR); and APHIS, Veterinary Services and WS.

Aerial baiting was conducted from fixed wing aircraft from 18 August-17 September 2003; 1,421,517 baits were distributed across 18 counties (Figure 1). Of the 1.4 million baits distributed, 520,695 baits were distributed across the 50.44 km² 2003 expansion and 17,627 baits were distributed in Armstrong County (Area 4) as part of a low-bait density (37.5 baits/km²) research project. Three additional research areas were baited at densities of 300 baits/km² (Area 1), 150 baits/km² (Area 2), and 75 baits/km² (Area 3) (Figure 1). The objective of the research was to determine if bait density affected rates of positive titers in raccoons.

Aircraft and flight crews for the 2003 ORV program were provided by the Ontario Ministry of Natural Resources and Dynamic Aviation. Ground support for the flights was provided by the Pennsylvania, Maryland, Ohio, and West Virginia WS, Ohio Department of Health, and Ohio National Guard.

Surveillance

During 2003, WS in Pennsylvania placed greater emphasis on enhanced rabies surveillance than in previous years; 1,309 animals were submitted and tested for rabies from within the 2003 ORV bait zone. Four percent (4%) of the animals submitted tested positive for rabies. Also, 14,454 kilometers (8,981 miles) were driven from June-December 2003, with coverage in 18 counties. Road kill enhanced surveillance efforts were concentrated in a 24.2 km (15 mile) buffer strip between the Pennsylvania and Ohio border. In cooperation with the Pennsylvania Game Commission, local animal control businesses, and local and State police departments, WS submitted 84 road-killed animals for rabies testing (Table 1).

Table 1. Animals collected for rabies testing from road kill surveys in Pennsylvania, June-December, 2003.

Species	Number collected	Number positive for rabies
Raccoon	66	2 (3%)
Feral cat (<i>Felis catus</i>)	6	0
Stripped skunk (<i>Mephitis mephitis</i>)	5	0
Red fox (<i>Vulpes vulpes</i>)	4	0
Gray fox (<i>Urocyon cinereoargenteus</i>)	1	1 (100%)
Mink (<i>Mustela vison</i>)	2	0
Totals	84	3 (3.6%)

Population Monitoring

Raccoon relative density studies were conducted from July-October 2003 in Erie and Armstrong Counties. Two study areas, per county, were sampled for this research project and relative density estimates were calculated (Table 2). All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Table 2. Estimated relative density (raccoons/km²) of raccoon populations on 4 study sites in 2 Pennsylvania counties, 2003.

Area	Density
Erie County	15.5
Armstrong County	16

Pre-bait Evaluation

Pre-bait ORV random trapping occurred from 4-6 June 2003 and pre-bait ORV research trapping occurred from 9 June-1 August 2003 (Table 3). Trapping protocols were established in cooperation with the WS, National Wildlife Research Center (NWRC), Ft. Collins, Colorado.

Table 3. Pre-bait ORV raccoon surveillance trapping on random and research sites in Pennsylvania, 2003.

	Collection period	
	Pre-bait ORV, random	Pre-bait ORV, research
Trap nights	71	3,905
Unique raccoons	16	269
Recaptured raccoons	0	38
Total raccoons	16	307
Trap success ^a	23%	7%
Non-target animals	3 (4%)	188 (5%)

^aunique raccoons

Post-bait Evaluation

Post-bait ORV random trapping occurred from 22 September-14 November 2003 and post-bait ORV research trapping occurred from 25 September-18 October 2003 (Table 4).

Table 4. Post-bait ORV raccoon surveillance trapping on random and research sites in Pennsylvania, 2003.

	Collection period	
	Post-bait ORV, random	Post-bait ORV, research
Trap nights	1,555	3,073
Unique raccoons	152	225
Recaptured raccoons	6	18
Total raccoons	158	243
Trap success ^a	10%	7%
Non-target animals	91 (6%)	155 (5%)

^aunique raccoons

Non-target Captures

Four hundred thirty seven (437) non-target animals (11 mammal species and 3 avian species) were captured and released unharmed during 8,604 trap nights in 2003, and included: 19 Eastern cottontail rabbits (*Sylvilagus floridanus*), 19 feral cats, 1 feral dog (*Canis familiaris*), 1 gray squirrel (*Sciurus carolinensis*), 2 muskrats (*Ondatra zibethicus*), 4 Norway rats (*Rattus norvegicus*), 247 opossum (*Didelphis virginiana*), 1 porcupine (*Erethizon dorsatum*), 1 red-tailed hawk (*Buteo jamaicensis*), 3 red squirrel (*Tamiasciurus hudsonicus*), 1 ruffed grouse (*Bonasa umbellus*), 46 striped skunks, 1 sparrow (species unknown), and 98 woodchucks (*Marmota monax*).

ORV PROGRAM 2002-EVALUATION

Serology, Tetracycline Biomarker, and Age Results

During the 2002 pre-bait ORV evaluation phase in Pennsylvania 66 and 232 unique raccoons were captured, through general random trapping for samples and as a part of research study sites, respectively. During the 2002 post-bait ORV evaluation phase in Pennsylvania, 123 and 192 unique raccoons were captured, through general random trapping and as a part of research study sites, respectively. Blood and tooth samples were taken from most of these animals for ORV program evaluation (Table 5, Figure 2, Figure 3, and Figure 4).

Table 5. Serology and tetracycline biomarker results of raccoon biological samples collected during ORV evaluation in Pennsylvania, 2002.

	Collection period			
	Pre-bait ORV, random	Pre-bait ORV, research	Post-bait ORV, random	Post-bait ORV, research
Serology				
Unique raccoons captured	66	232	123	192
Testable blood samples	52	146	117	189
Positive rabies antibody response ^a	7 (13.5%)	10 (6.8%)	19 (16.2%)	23 (12.2%)
Tetracycline biomarker				
Unique raccoons captured	66	232	123	192
Testable tooth samples	51	56	120	184
Presence of tetracycline biomarker	27 (52.9%)	2 (3.6%)	0	76 (41.3%)

^aCenters for Disease Control and Prevention serum dilution ≥ 5

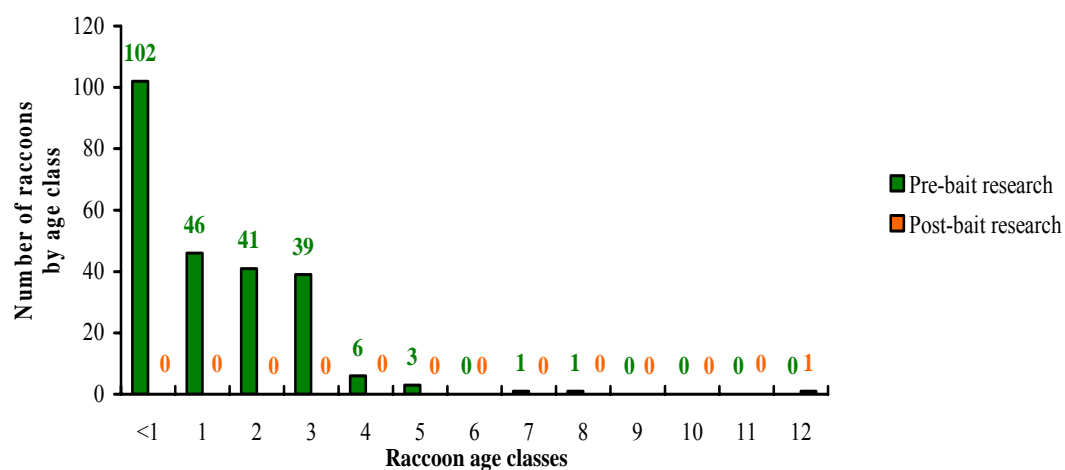


Figure 2. Age class distribution from 240 of 424 research raccoon biological samples collected during pre- and post-bait ORV evaluation in Pennsylvania, 2002.

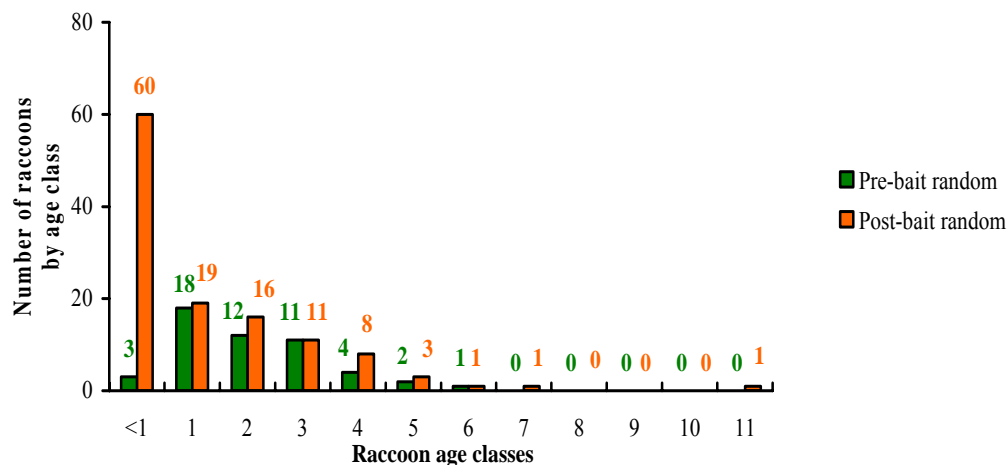


Figure 3. Age class distribution from 171 of 189 random raccoon biological samples collected during pre- and post-bait ORV evaluation in Pennsylvania, 2002.

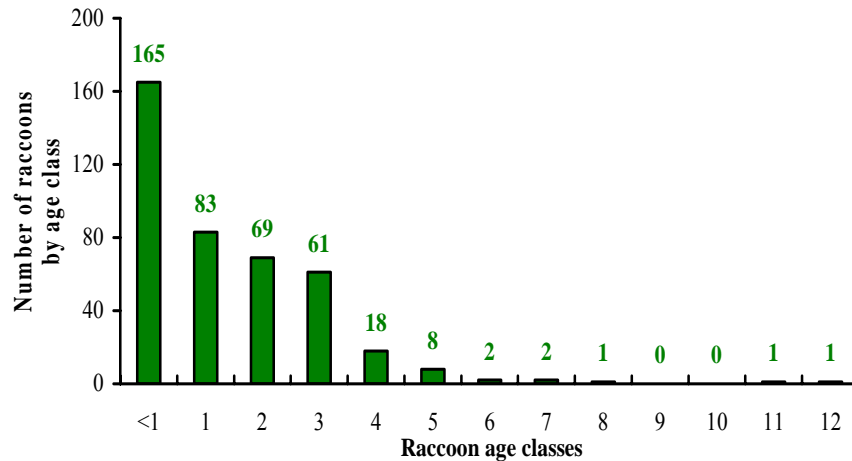


Figure 4. Age class distribution from 411 of 613 raccoon biological samples collected during all ORV evaluation phases in Pennsylvania, 2002.

SUMMARY

During 2003, WS completed the third year of cooperative participation in the Pennsylvania ORV program, distributing 1,710,399 ORV baits. Baits were distributed by hand and from aircraft across 18 counties encompassing 25,189 km². Over 3.1 million ORV baits have been distributed in Pennsylvania since baiting began in 2001.

Pennsylvania's baiting effort is part of a larger Appalachian Ridge ORV effort, which in 2003, included Maryland, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. In 2004, the Pennsylvania ORV program will continue to distribute baits across the same 18 county area covered in 2003, with the addition of a spring baiting area (1,166 km²), located in a previously unbaited portion of the state. The Erie County ground bait study and the low bait density study in Armstrong County continue to provide additional data on baiting densities and raccoon population densities.

The Pennsylvania ORV program is an integral part of the larger Appalachian Ridge cooperative effort, which in turn, is tied to national planning efforts to contain the raccoon rabies strain and explore strategies to eliminate this unique variant of the rabies virus.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM TENNESSEE 2003

BACKGROUND

The Tennessee oral rabies vaccination (ORV) program was initiated in 2002 as part of Wildlife Services (WS) national program to stop the westward spread of the raccoon (*Procyon lotor*) strain rabies. Raccoon strain rabies had not been found in Tennessee prior to 2002. In June 2003, the rabies front, which had stalled in North Carolina, finally crossed over into upper east Tennessee. Four positive cases were documented in raccoons in Carter County and 1 positive case was documented in a feral cat (*Felis catus*) in Johnson County. Prior to 2003, raccoon strain rabies was documented in counties bordering Tennessee, in western North Carolina in 1997 and in northern Georgia in 2001. In an effort to stay ahead of this disease front, WS decided to extend the ORV bait area into Tennessee and anchor it in the high elevations of the Appalachian Mountains.

The Georgia-Alabama-Tennessee (GAT) ORV program was initiated in 2003 to complement the Appalachian Ridge ORV program and to prevent the spread of raccoon strain of rabies into the Tennessee Valley and subsequently the interior of the United States. The barrier created by the GAT ORV program begins in southeastern Tennessee and extends southward into northern Georgia and Alabama. Ultimately, the GAT barrier will be extended south, through Alabama and together with the Appalachian Ridge barrier, will create a continuous barrier from Lake Erie to the Gulf of Mexico.

The Tennessee ORV program is being conducted by WS, in cooperation with the Tennessee Department of Health, Tennessee Department of Agriculture, Chattanooga/Hamilton County Department of Health, and the Centers for Disease Control and Prevention. The Tennessee Valley Authority, Holston Army Ammunition Facility, Phipps Bend Industrial Park, Tennessee River Gorge Trust Association, Chattanooga Audubon Society, Chattanooga Parks and Recreation, Chattanooga Municipal Airport, Moccasin Bend Mental Health Institute, Tennessee Wildlife Resources Agency, and separate individual landowners provided access to private and government owned properties for ORV program trapping and monitoring. Fiscal Year 2003 ORV program expenses, by Tennessee WS, totaled \$926,587 (Table 1).

Table 1. Oral rabies vaccination program expenditures by Tennessee WS, Fiscal Year 2003.

ORV Program	Baits	Aircraft expenses	Personnel (salary/benefits/travel)	Equipment/supplies and services	Total
Appalachian Ridge Area	\$204,368	\$31,138	\$71,831	\$142,250	\$449,587
GAT Area	\$329,184	\$4,574	\$43,941	\$99,301	\$477,000
Total	\$533,552	\$35,712	\$115,772	\$241,551	\$926,587

ORV PROGRAM 2003

Bait Distribution

Appalachian Ridge ORV Program.--The ORV program in Tennessee in 2003 was conducted on 2 fronts, the Appalachian Ridge area in northeast Tennessee and the GAT area in southeast Tennessee. The 2003 Appalachian Ridge bait zone covered 3,232 km² (1,243 mi²) over 7 counties (Figure 1). Aerial distribution of 212,785 baits occurred from 21 September-7 October and hand distribution of 20,080 baits occurred from 6-8 October. Fishmeal polymer baits (FMP), containing Raboral V-RG® vaccine (Merial Limited, Athens, Georgia, USA), were used for both ORV programs. Aircraft and flight crew for the 2003 ORV programs were provided by the Ontario Ministry of Natural Resources and Dynamic Aviation.

Georgia-Alabama-Tennessee ORV Program.--The 2003 GAT area bait zone covered 1,014 km² (390 mi²) over 3 counties (Figure 1). Aerial distribution of 28,322 FMP baits occurred from 13-15 November and hand distribution of 38,880 FMP baits occurred from 16-18 November.

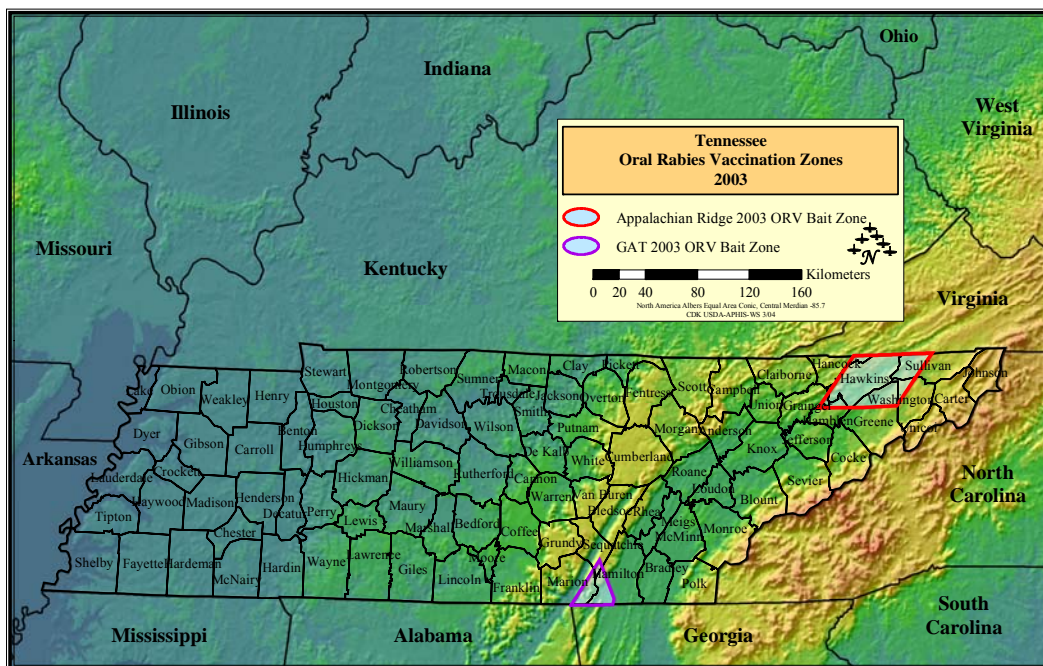


Figure 1. Oral rabies vaccination zones in Tennessee, 2003.

Surveillance

In 2003, WS initiated enhanced surveillance for the raccoon strain of the rabies virus in Tennessee. Wildlife Services personnel met with regional directors of the Tennessee Department of Health and recruited Health Department personnel and local animal control officers to begin collecting suspect animals for testing. An emphasis was placed on raccoons, striped skunks (*Mephitis mephitis*), gray foxes (*Urocyon cinereoargenteus*), red foxes (*Vulpes vulpes*), and coyotes (*Canis latrans*) that displayed unusual behavior, were found dead in unusual places, or were fresh road-killed animals. Twenty one counties in east Tennessee that bordered Virginia, North Carolina, Georgia, and Alabama were selected for enhanced surveillance. These efforts resulted in the collection and testing of 86 raccoons, 7 striped skunks, 7 gray foxes, 3 red foxes, and 1 coyote. One of the raccoons collected from Carter County became the fifth positive raccoon strain of rabies case in Tennessee.

In response to the raccoon strain of rabies case discovered inside the GAT baiting area, WS will conduct intensive enhanced surveillance, including trapping, in February 2004.

Population Monitoring

Appalachian Ridge ORV Program.--Wildlife Services protocol for relative density population estimation was used to estimate raccoon abundance in Tennessee during July 2003. Two individual density studies were conducted in the Appalachian Ridge area. The Phipps Bend Industrial Park was situated at 335 meters in elevation. Habitat was typical of a large portion of the state, with a mixture of upland hardwood forest, river bottom, and crop fields, such as hay and corn. The Holston Army Ammunition Facility was situated at 370 meters in elevation and was primarily forested with upland hardwoods intermingled with small stands of pine. Thirty five (35) unique raccoons were captured at Phipps Bend and 45 unique raccoons were captured at the army facility, resulting in estimated relative densities of 12 and 15 raccoons/km², respectively. All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Georgia-Alabama-Tennessee ORV Program.--Wildlife Services protocol for relative density population estimations was used to estimate raccoon abundance in the GAT area of Tennessee, in conjunction with post-bait surveillance trapping during January 2004. The area selected for the study was situated at 500 meters in elevation and was primarily upland hardwood forest on limestone substrate. There were no raccoons captured during this density study, resulting in an estimated relative density of <1 raccoon/km².

Post-bait Evaluation

Appalachian Ridge ORV Program.--After the September-October bait drop, WS conducted post-bait ORV trapping of raccoons to collect blood and tooth samples and measure program success. From November-December 2003, trapping occurred on 10 study sites (3 forested, 6 agriculture, and 1 urban/suburban), yielding 153 unique raccoons.

Georgia-Alabama-Tennessee ORV Program.--After the November bait drop, WS conducted post-bait ORV trapping of raccoons to collect blood and tooth samples and measure program success. From December 2003-January 2004, trapping occurred on 9 study sites (6 urban/suburban and 3 forested), yielding 64 unique raccoons.

Non-target Captures

Appalachian Ridge ORV Program.--Non-target species that were captured and released during the relative density studies and post-bait ORV trapping included: 112 opossums (*Didelphis virginiana*), 21 feral cats, 2 Eastern cottontail rabbits (*Sylvilagus floridanus*), 1 striped skunk, and 2 fox squirrels (*Sciurus niger*).

Georgia-Alabama-Tennessee ORV Program.--Non-target species captured and released during the relative density study and post-bait ORV trapping included: 33 opossums, 5 feral cats, 1 Eastern cottontail rabbit, and 1 gray fox.

ORV PROGRAM 2002-EVALUATION

Serology, Age, and Tetracycline Biomarker

Appalachian Ridge ORV Program.--Trapping of raccoons was conducted as part of the relative density study and for post-bait ORV evaluation. Blood and tooth samples were collected from captured raccoons to measure program success. Twenty seven (27) unique raccoons were captured as part of the relative density study conducted during July 2002 and 74 unique raccoons were captured as part of the post-bait ORV evaluation during late November and early December 2002 (Table 2, Figure 2, and Figure 3).

Table 2. Serology and tetracycline biomarker results of raccoon biological samples collected during relative density and post-bait ORV evaluation in Tennessee, 2002.

	Density study	Post-bait ORV
Serology		
Unique raccoons captured	27	74
Testable blood samples	27	74
Positive rabies antibody response ^a	2 (7.4%)	8 (10.8%)
Tetracycline biomarker		
Unique raccoons captured	- ^b	55
Testable tooth samples	-	54
Presence of tetracycline biomarker	-	7 (13.0%)

^aCenters for Disease Control and Prevention serum dilution ≥ 5

^bno teeth collected, ORV zone not previously baited

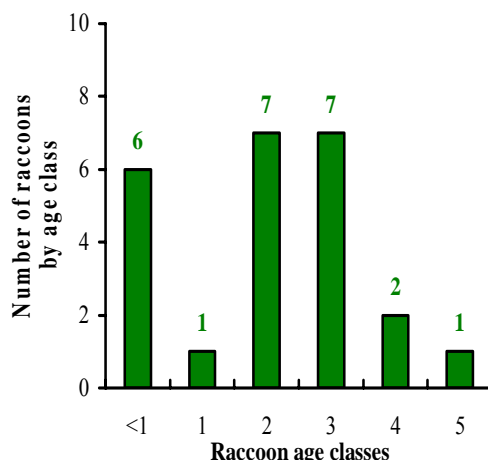


Figure 2. Age class results from 24 of 27 raccoon biological samples collected during a relative density study in Tennessee, 2002.

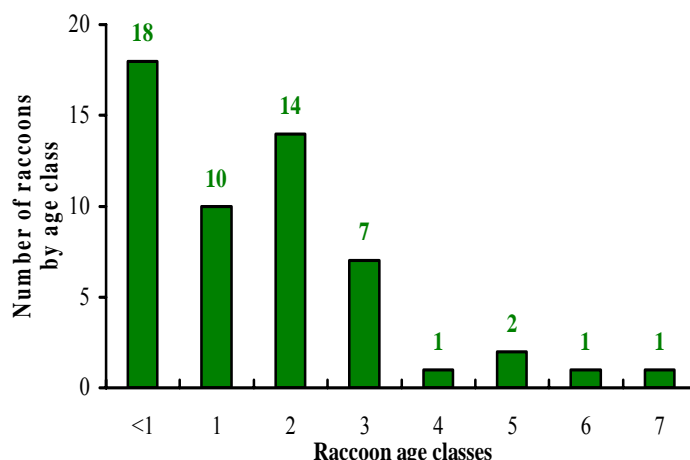


Figure 3. Age class results from 54 of 74 raccoon biological samples collected during the post-bait ORV evaluation phase in Tennessee, 2002.

SUMMARY

In 2003, Tennessee WS conducted its second year of rabies control activities as part of the Appalachian Ridge ORV program and launched an additional ORV program in the GAT area. During the bait drops, 58,960 FMP baits were distributed by hand and 243,025 FMP baits were distributed by air, in portions of 10 east Tennessee counties. Post-bait drop trapping resulted in the collection of 217 animals for virus neutralizing antibody testing. Enhanced surveillance efforts resulted in the collection and testing of 104 animals and revealed a positive raccoon in Carter County.

During 2004, WS will continue to conduct and coordinate enhanced surveillance for raccoon strain rabies in east Tennessee. Efforts will be made to recruit additional local law enforcement agencies, Tennessee Wildlife Resources personnel, and the general public to report and collect suspected rabid animals in 21 counties in east Tennessee. Additional relative density study areas and monitoring sites will be secured to look at potential differences in raccoon population trends among different habitats, elevations, and ORV areas.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM TEXAS 2003

BACKGROUND

Since 1980, >90% of reported rabies cases have involved wild animals. Several different strains of the rabies virus are present in the United States. Each strain is spread predominantly by 1 wildlife species, but all strains are capable of infecting warm-blooded mammals, including humans. Currently, raccoons (*Procyon lotor*) and skunks (family *Mustelidae*) spread most reported rabies cases in the United States, but bats (order *Chiroptera*), gray foxes (*Urocyon cinereoargenteus*), and coyotes (*Canis latrans*) also have a significant impact as wildlife carriers of rabies.

Two canine rabies epizootics (epidemics in animals) emerged in Texas in 1988, 1 involving coyotes and dogs (*C. familiaris*) in south Texas and the other involving gray foxes in west-central Texas. The south Texas epizootic has resulted in 2 human deaths and required over 3,000 people to receive post exposure rabies treatment. In 1994, the public health threat created by these 2 expanding epizootics prompted the Governor of Texas to declare rabies a state health emergency. The 2 epizootics expanded to involve 69 Texas counties by 1996. In February of 1995, an oral rabies vaccination program (ORVP) was initiated as a multiyear effort with a goal of creating zones of vaccinated coyotes and gray foxes (January 1996) along the leading edges of the epizootics, thereby halting the spread of the virus. The ORVP is a cooperative program involving Wildlife Services (WS); Texas Department of Health (TDH); Texas Cooperative Extension-Wildlife Services; Texas National Guard; Centers for Disease Control and Prevention (CDC); United States Army Veterinary Laboratory, located at Ft. Sam Houston; and other local, state, and federal agencies.

ORV PROGRAM 2003

Bait Distribution-Coyote

During January 2003, WS participated as a member of the ORVP in the aerial distribution of 717,050 oral rabies vaccine (ORV) baits to prevent the spread of canine rabies in coyotes in south Texas. Fixed-wing aircraft services, used for the aerial distribution of baits, were provided by Dynamic Aviation. Coyote baits were composed of fishmeal polymer (FMP) and contained 2 milliliters of Raboral V-RG® vaccine (MERIAL Limited, Athens, Georgia, USA). Total area baited for coyotes was 31,080 km² (Figure 1).

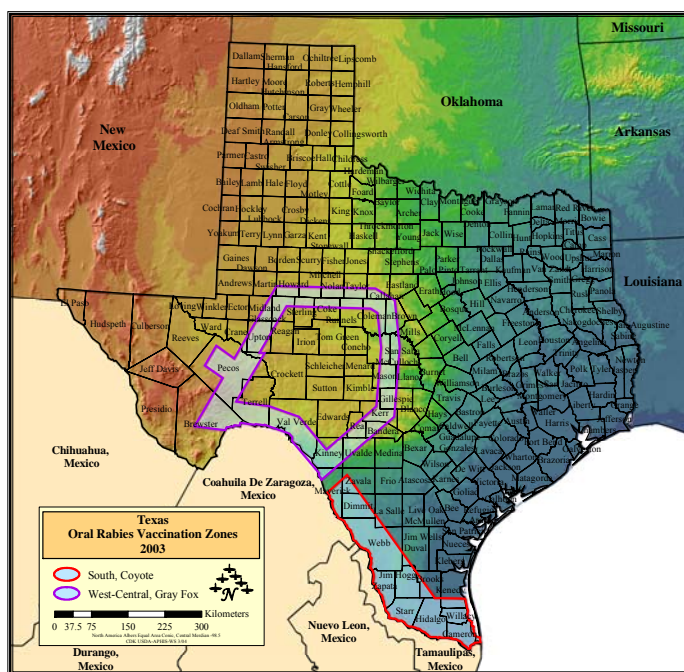


Figure 1. Coyote and gray fox ORV bait zones in Texas, 2003 (Bait zone data provided by TDH).

Bait Distribution-Gray Fox

During January 2003, WS also participated as a member of the ORVP in the aerial distribution of 1,829,400 ORV baits to contain an outbreak of rabies unique to gray foxes in west-central Texas. An additional 3,960 gray fox ORV baits were placed by hand in Fort Stockton and 540 ORV baits were placed in Sanderson, Texas. Gray fox baits were composed of dog food and also contained 2 milliliters of Raboral V-RG® vaccine. Total area baited for gray foxes was 49,210 km² (Figure 1). With the 1.55 million ORV baits supplied by WS during 2003, the Texas ORVP cooperative effort was able to encircle the gray fox rabies epizootic.

ORV PROGRAM 2003-EVALUATION

Annual evaluations of the ORVP are based on 3 criteria: (1) that the edible baits (FMP and dog food complex) contain 150 mg of tetracycline, which is used as a biomarker in dental tissue. Detection of the biomarker can be used to demonstrate the number of baits eaten, in a given year and the annual bait consumption by animals, over a period of multiple years. However, presence of tetracycline does not confirm that the vaccine sachet has been punctured or consumed; (2) the number of positive rabies antibody responses from animals collected within the vaccination zone (CDC serum dilution ≥ 5); and (3) the epidemiology of rabies cases in the target area. All biological samples collected to evaluate the success of the ORVP were obtained from target animals. No non-target animals were taken. All animals collected in 2003 were handled according to the American Veterinary Medical Association guidelines.

Coyote

In 2003, 30 coyotes were collected by TDH, for ORVP evaluation, from within the coyote vaccination zone. Twenty five of 30 (83%) of the coyotes tested were positive for the tetracycline biomarker included in the bait material and 23 of 30 (77%) of the coyotes tested from the surveillance area showed a positive rabies antibody response to the vaccine (Figure 2). Canine rabies cases, since the initiation of the ORVP in south Texas, have declined from 166, reported during the pre-program year in 1994, to 94 in 1995, 15 in 1996, 3 in 1997, 7 in 1998, 8 in 1999, 0 in 2000, 1 in 2001, and 0 in 2002. During 2003 no canine rabies cases were reported in South Texas.

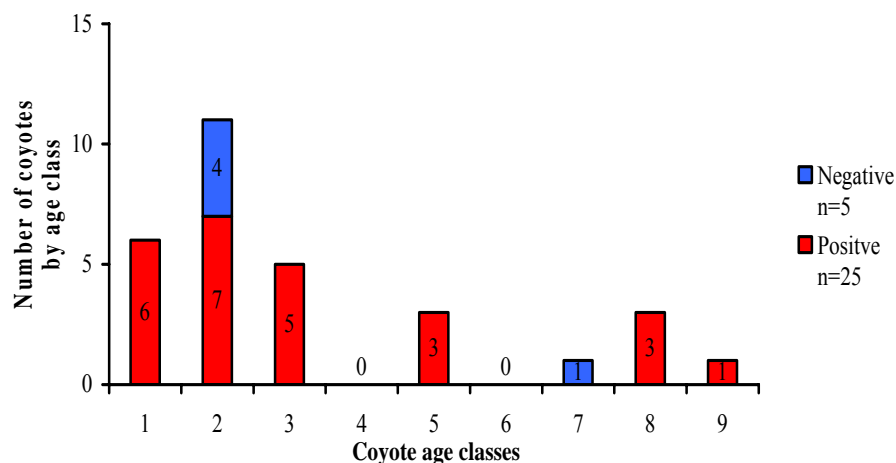


Figure 2. Age class results and presence/absence of tetracycline biomarker for 30 coyotes collected during post-bait ORVP evaluation in south Texas, 2003.

Gray Fox

During the evaluation phase of the gray fox 2003 ORVP in west-central Texas WS and the TDH collected 129 gray foxes. Blood and tooth samples were taken from captured animals for ORVP evaluation (Table 1 and Figure 3).

Table 1. Serology and tetracycline biomarker results of biological samples collected during post-bait ORVP evaluation in west-central Texas, 2003.

Species	Presence of tetracycline biomarker	Positive rabies antibody response	Total
Gray fox	47 (37%)	88 (68%)	129
Coyote	13 (25%)	31 (60%)	52
Skunk	NA ^a	16 (55%)	29
Raccoon	NA	7 (41%)	17
Bobcat (<i>Felis rufus</i>)	NA	1 (50%)	2
Ringtail (<i>Bassariscus astutus</i>)	NA	0	1
Feral cat (<i>F. cattus</i>)	NA	0	2
Opossum (<i>Didelphis virginiana</i>)	NA	0	1

^adata not available

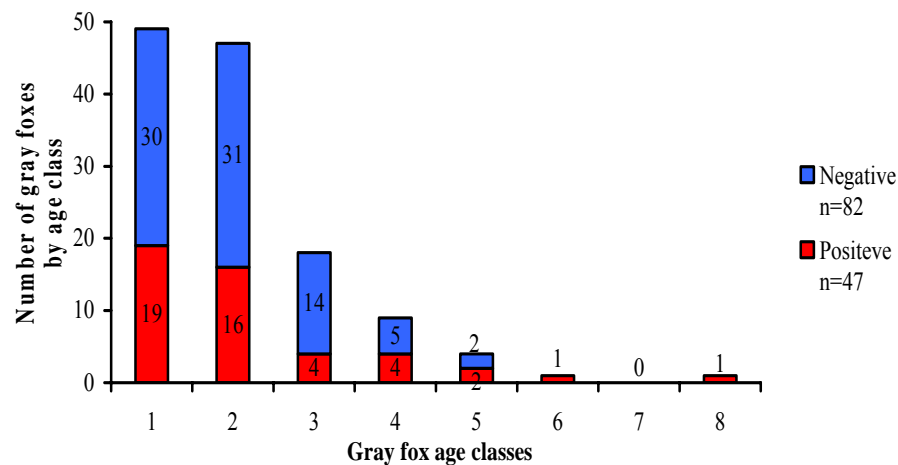


Figure 3. Age class results and presence/absence of tetracycline biomarker for 129 gray foxes collected during post-bait ORVP evaluation in west-central Texas, 2003.

The gray fox ORVP in west-central Texas also has shown program success with 188 rabies cases reported during the pre-program year in 1995, 57 in 1996, 30 in 1997, 43 in 1998, 74 in 1999, 39 in 2000, 20 in 2001, and 65 in 2002. In 2002, of the 65 total cases of gray fox rabies reported, 18 cases occurred in Pecos County, outside the western edge of the gray fox vaccination zone. Several factors may have contributed to the breach in the ORV barrier during 2002. One factor may have been the interruption of the ORV baiting program for 2 consecutive years. During 2000 and 2001 reduced funding for ORVP only allowed for the distribution of vaccine baits along the eastern edge of the epizootic to protect the state's major metropolitan areas. In 2002, with restored levels of ORVP funding, the northern and western edge of the gray fox vaccination zone were re-established. Increased ORVP funding for 2003 enabled the blanket treatment of the Pecos County foci, as well as the encirclement of the gray fox rabies epizootic area. During 2003, only 4 of 61 (6.6%) cases of gray fox rabies were reported in Pecos County. The remaining 57 cases were inside the immune barrier.

SUMMARY

Since 1995, 9.35 million vaccine baits have been distributed over south Texas by the ORVP, which has proved to be highly effective in the elimination of the canine rabies strain in that area. Since the last case of canine rabies in south Texas was reported on 15 February 2001, within just a few miles of the United States-Mexico border in Webb County, and none since, it is believed that the virus has been eliminated from Texas. A maintenance strategy has been developed which will maintain a zone of immunized wildlife along the southern Texas border to prevent future re-emergence of the virus. With continued support for the cooperative ORVP effort, similar success is sought in the gray fox epizootic in west-central Texas where 10.6 million fox baits have been distributed since 1996.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM VERMONT 2003

BACKGROUND

Raccoon (*Procyon lotor*) rabies first entered Vermont in 1994. It quickly spread and has been confirmed in all 14 counties in the state. In <2 years, raccoon rabies had spread through 8 counties in Vermont and by the spring of 1996 was approximately 73 km (45.5 miles) south of the United States-Canada border. In May 1997, an intensive oral rabies vaccination (ORV) program was initiated with the goal of preventing the northward spread of raccoon rabies into Canada. In 1997, 1,637 km² (632 mi²) were baited in Vermont. That area has since quadrupled in size to the current 2003 program of 6,541 km² (2,525 mi²). The 2003 bait zone utilized potential natural barriers (Lake Champlain to the west and the Connecticut River to the east) to contain the spread of rabies and encompassed approximately 35% of the state (Figure 1). Since 1997, through aerial and hand bait distribution, nearly 1.5 million fishmeal polymer (FMP) and fishmeal-coated sachet (CS) baits, containing Raboral V-RG® vaccine (MERIAL Limited, Athens, Georgia, USA) have been distributed over northern Vermont.

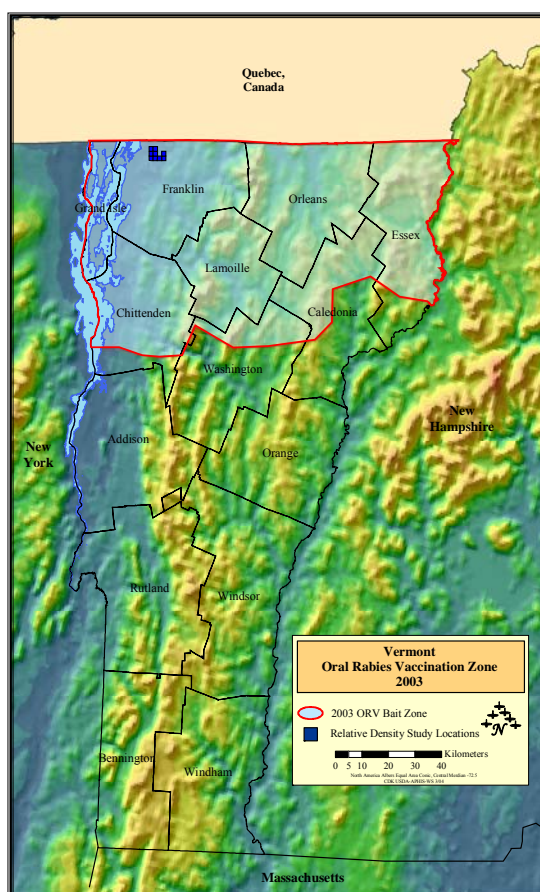


Figure 1. Oral rabies vaccination zone and relative density study locations in Vermont, 2003.

This cooperative ORV effort is lead by Cornell University (CU). Wildlife Services (WS) has been the major source of federal funds for project implementation. Wildlife Services has also provided federal wildlife management leadership by continuing to play an active role in: project planning and coordination; organizing ground support for the bait drop; working in and navigating aircraft to distribute baits; coordinating the hand distribution of baits in areas too populated to bait by air; evaluating if the Green Mountains serve as a natural barrier to the movement of raccoon rabies; and providing surveillance and follow-up field work by collecting blood and tooth samples from live-trapped and suspect-rabid animals, within the ORV bait zone, to test program efficacy. Wildlife Services costs associated with ORV program activities, in Fiscal Year 2003, totaled \$608,490 (Table 1).

Table 1. Vermont WS ORV program costs, Fiscal Year 2003.

Item	Cost
Baits ^a	\$379,000
Salaries	\$135,067
Other (equipment, travel, etc.)	\$89,423
Vermont Department of Health ^b	\$5,000
Total	\$608,490

^afunds given to CU for purchase of 378,708 baits.

^bfunds given to VDH to fund an intern to assist with bait distribution and suspect-rabid animal collections.

ORV PROGRAM 2003

Bait Distribution

The summer of 2003 marked the seventh consecutive year of the Vermont ORV program. The 2003 bait zone was a replicate of the 2002 bait zone. During 20 flights, 318,425 CS baits were distributed by Twin Otter fixed-wing aircraft from 25-27 August, while 8,890 FMP baits were distributed by hand from 22 August-5 September. Number of baits distributed in Vermont during the 2003 field season were 327,315. Coated sachet and FMP baits cost \$1.00/bait and \$1.27/bait, respectively. Aircraft and flight crew for the 2003 ORV bait drop were provided by the Ontario Ministry of Natural Resources. Ground and baiting support also was provided by WS, CU, and the Vermont Department of Health (VDH). Wildlife Services receives formal permission to conduct aerial bait drops from the VDH, the Vermont Fish and Wildlife Department (VFWD), and the Vermont Agency of Agriculture, Food, and Markets.

Population Monitoring

Since 1997, WS has conducted 36 raccoon relative density studies in northern Vermont to establish population trends in areas of common agricultural habitat and to determine density indices at higher elevations (>500m). Each study has been conducted using an established protocol of 50 cage traps over 10 consecutive nights (500 trap nights) on a 3 km² (1.16 mi²) study area. Relative densities from these studies ranged from 2 raccoons/km² (5.2 raccoons/mi²) to 15 raccoons/km² (38.9 raccoons/mi²). All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

On 13 September 2003, WS replicated a large-scale raccoon relative density study in the towns of Highgate and Franklin (near the Quebec, Canada border) that was previously conducted in September 2001 and 2002. Nine concurrent relative density studies were conducted using a standard density index protocol. In cooperation with WS personnel from 4 different states, 192 unique raccoons were captured on the 9 contiguous cells, representing 27 km² (10.4 mi²), over 4,500 trap nights (Table 2). Over the 3-year study, 647 unique raccoons were captured on the same 27 km² (10.4 mi²) area of land in northern Vermont. The 3-year data set from these studies will provide valuable information on raccoon population dynamics, critical to refining ORV program strategies.

Table 2. Raccoon population monitoring efforts in Highgate and Franklin, Vermont, 2001-2003.

	2001	2002	2003
Trap nights	4,500	4,500	4,500
Unique raccoons	211	244	192
Recaptured raccoons	56	75	48
Trap success ^a	4.7%	5.4%	4.3%
Non-target captures	57	98	93
Average raccoon relative density index ^b	7.8	9.0	7.1

^aunique raccoons

^b(raccoons/km²)

POST-BAIT EVALUATION

Since 1997, WS has led post-bait ORV sampling, which is an essential component to the evaluation phase of the Vermont ORV program. Blood and tooth samples are taken from each live-trapped raccoon; the animal is weighed and marked with a small ear tag and released back into the wild at the point of capture. The blood serum is later analyzed to detect virus neutralizing antibodies and the tooth is analyzed to determine age and bait uptake (for FMP baits with biomarker). Fishmeal polymer baits contain tetracycline that indicates whether a raccoon consumed at least the outer portion of the bait. However, presence of tetracycline does not confirm that the vaccine sachet has been punctured or consumed. Coated sachet baits do not contain this biomarker.

Wildlife Services live-trapped 344 raccoons during the 2003 evaluation phase. Blood and tooth samples were collected from most of these animals. These samples will be used to compare immune status and bait uptake of the raccoon population in the 2003 ORV zone to raccoon populations from 1997-2002. In addition, WS live-trapped 71 striped skunks (*Mephitis mephitis*) during the 2003 evaluation phase. Blood samples were taken from 46 of these skunks; no tooth samples were collected.

In addition to 344 raccoons and 71 skunks, 32 additional animals (representing 13 species) were live-trapped as non-targets, for a total of 447 individuals captured during the 2003 ORV evaluation phase (Table 3). Thirty seven of 344 raccoons captured were euthanized. The majority of these raccoons (34) were removed from State-owned land, at the request of the VFWD, to reduce raccoon egg predation on nesting State-threatened Eastern spiny softshell turtles (*Apalone spinifera*). Two raccoons were euthanized after exhibiting rabies-like signs (both tested negative for rabies); a third raccoon was removed from a residence within the ORV zone for nuisance reasons. One red squirrel (*Tamiasciurus hudsonicus*) was found dead in a cage trap. All other animals captured were released unharmed.

Table 3. Non-target animals trapped during the Vermont ORV evaluation phase, 2003.

Species	Number	Species	Number
Blue jay (<i>Cyanocitta cristata</i>)	1	Porcupine (<i>Erethizon dorsatum</i>)	1
Cat (<i>Felis catus</i>)	12	Red fox (<i>Vulpes vulpes</i>)	2
Fisher (<i>Martes pennanti</i>)	4	Red squirrel	2
Gray squirrel (<i>Sciurus carolinensis</i>)	2	Ruffed grouse (<i>Bonasa umbellus</i>)	2
Mink (<i>Mustela vison</i>)	1	Snapping turtle (<i>Chelydra serpentina</i>)	2
Muskrat (<i>Ondatra zibethicus</i>)	1	Woodchuck (<i>Marmota monax</i>)	1
Northern flicker (<i>Colaptes auratus</i>)	1	Total	32

OTHER RABIES ACTIVITIES

Throughout 2003, WS provided assistance to the VDH by collecting and submitting wild animals exhibiting rabies-like signs, wildlife involved in human exposure cases, and road-killed wildlife. Forty three animals (36 raccoons, 4 skunks, and 3 little brown bats [*Myotis lucifugus*]) were submitted from 7 counties to the VDH; 1 skunk tested positive for the raccoon strain of the rabies virus.

ORV PROGRAM 2002-EVALUATION

Serology results that are reported from the New York State Department of Health (NYSDH) lab are represented in International Units (IU). This is different than what has been previously reported by the Centers for Disease Control and Prevention (serum dilution <5 and ≥ 5), which conducts serologic analysis for many states in the cooperative ORV program.

Serology, Tetracycline Biomarker, and Age Results

In 2002, during the Vermont evaluation phase of the ORV program, 344 raccoons (31 pre-bait and 313 post-bait) were live-trapped within the CS bait zone. Blood and tooth samples were taken from most of these animals for ORV program evaluation (Table 4, Table 5, and Figure 2).

Table 4. Serology results of raccoon biological samples collected during pre- and post-bait ORV program evaluation in Vermont, 2002.

	Pre-bait	Post-bait
Unique raccoons captured	31	313
Testable blood samples	31	311
Sero-reactive ^a	3 (9.7%)	59 (19.0%)
Sero-positive ^b	6 (19.4%)	45 (14.5%)

^aNYSDH serum titer 0.125-0.25 IU

^bNYSDH serum titer ≥ 0.5 IU

Table 5. Tetracycline biomarker results of raccoon biological samples collected during pre- and post-bait ORV program evaluation in Vermont, 2002 (2% [129 km² of 6,541 km²] of total area baited in Vermont was baited with FMP baits, containing the tetracycline biomarker).

	Pre-bait	Post-bait
Unique raccoons captured	31	313
Testable tooth samples	31	294
Total presence of tetracycline biomarker	7 (22.6%)	39 (13.3%)
Year of detection:		
Year of detection unknown	4 (57.1%)	11 (28.2%)
2001	3 (42.9%)	5 (12.8%)
2002	0 ^a	23 (59.0%)

^a2002 bait drop had not yet occurred



Figure 2. Age class results from 330 of 344 raccoon biological samples collected during pre- and post-bait ORV program evaluation in Vermont, 2002.

SUMMARY

The summer of 2003 marked the seventh year of WS cooperative participation in the Vermont ORV program. Over those 7 years, the VDH has confirmed 512 cases of the raccoon strain of rabies in Vermont; only 18 (3.5%) of those cases occurred inside the ORV zone. Based on the annual spread rate of about 35 miles/year, raccoon rabies was expected to have crossed the Vermont-Quebec, Canada border by 1999. Intervention with 1,482,422 ORV baits, containing Raboral V-RG®, over northern Vermont since 1997, has been instrumental in preventing raccoon rabies from spreading northward.

Vermont WS cooperated with New Hampshire WS to coordinate ORV baiting and trapping efforts along the Connecticut River in northern New Hampshire during the 2003 field season. The Vermont and New Hampshire programs are an integral part of a larger Northeastern cooperative effort (that in 2003, included New York, Maine, and Quebec and Ontario, Canada), which in turn, is tied to national planning efforts to contain the raccoon strain of rabies and explore strategies to eliminate this unique strain of the rabies virus.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM VIRGINIA 2003

BACKGROUND

Wildlife Services (WS) has been conducting an oral rabies vaccination (ORV) program to control raccoon rabies in Virginia since 2002. The ORV program in Virginia is part of a nationwide, cooperative effort to stop the westward spread of the raccoon (*Procyon lotor*) strain of rabies in the eastern United States.

Raccoon rabies was first introduced to the mid-Atlantic region of the United States with the translocation of infected raccoons from Florida to Hardy County, West Virginia and Shenandoah County, Virginia in 1978 and 1979. From these counties, the disease spread rapidly along the east coast and has now become enzootic in all of the East Coast states, as well as Alabama, Pennsylvania, Vermont, and West Virginia, as well as intermittently in easternmost Ohio.

In Virginia, raccoon rabies occurs throughout the state, with the exception of 4 counties (Buchanan, Dickenson, Lee, and Wise) on the southwestern border with Kentucky. According to the Virginia Department of Health, Office of Epidemiology, infected raccoons accounted for 321 (59.2%) of the 542 animal rabies cases reported in Virginia in 2003. During the past 6 years, January 1998-December 2003, raccoons have accounted for 1,934 (57.9%) of the 3,339 laboratory confirmed cases of animal rabies statewide. Wildlife Services is working in cooperation with the Virginia Department of Health, the Virginia Department of Game and Inland Fisheries, and local animal control officers to provide as many surveillance specimens as possible.

ORV PROGRAM 2003

Bait Distribution

Aerial Baiting.--Aerial distribution of fishmeal polymer (FMP) ORV baits, containing Raboral V-RG® vaccine (MERIAL Limited, Athens, Georgia, USA), occurred throughout the vaccination zone from 21 September-7 October 2003. Baits were distributed from low-flying, fixed-wing aircraft, along flight lines spaced approximately 500 meters apart. Aerial baiting efforts in southwest Virginia required the flight of 12,546 km to cover the 5,669 km² area, included in the aerial ORV zone (Figure 1). Number of baits dropped in southwest Virginia during the aerial portion of bait distribution were 373,227. All, or part of, the cities and counties in Table 1, with their respective areas and aerial bait totals, were included in the ORV zone.

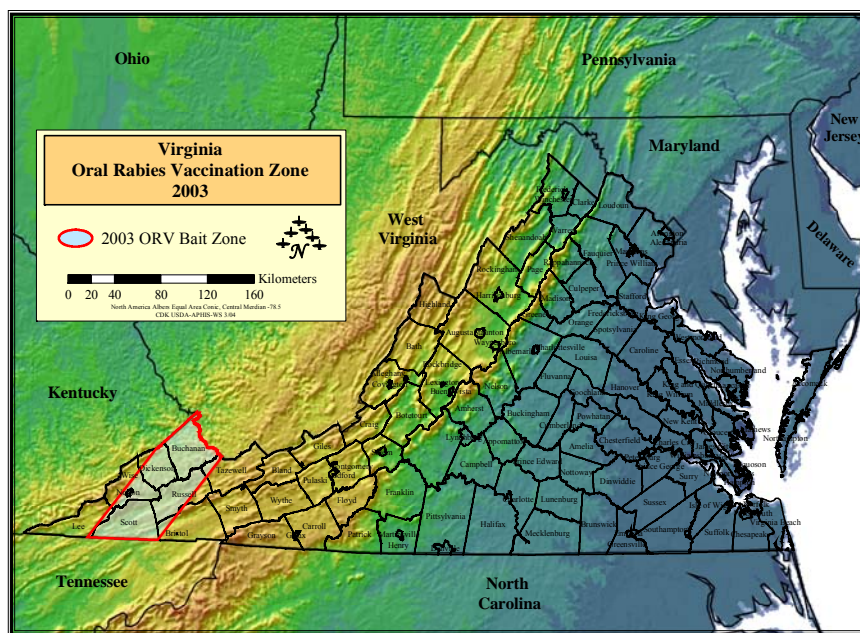


Figure 1. Oral rabies vaccination zone in southwest Virginia, 2003.

Table 1. Oral rabies vaccination aerial bait distribution in southwest Virginia, 2003.

County/city	Area (km ²)	Number of baits distributed
Buchanan	1,304.14	85,852
Dickenson	730.64	48,098
Lee	76.82	5,057
Norton	18.80	1,238
Russell	1,121.57	73,834
Scott	1,373.55	90,422
Tazewell	213.93	14,083
Washington	291.89	19,215
Wise	538.15	35,427
Total	5,669.49	373,227

Hand Baiting.--On 15-16 October 2003, WS distributed 16,440 ORV baits by hand from vehicles in many of the urban and suburban areas of southwest Virginia (Castlewood, Clinchco, Clintwood, Coeburn, Gate City, Grundy, Haysi, Honaker, Lebanon, Norton, St. Paul, Weber City, and Wise) that were within the bait distribution zone. These areas were too densely developed for aerial bait distribution. A total of 1,800 baits were distributed by hand in urban and suburban areas within Buchanan County; 1,800 in Dickenson County; 6,870 in Russell County; 2,370 in Scott County; 1,800 in Wise County; and 1,800 in the City of Norton.

Population Monitoring

Standard WS protocol was used to estimate the relative density of raccoons on 2 sites in southwest Virginia during July 2003. Five hundred (500) trap nights on an agricultural area, in western Russell County, resulted in the capture of 20 unique raccoons. A density index calculation, using the study area size of 2.6 km² and the number of individual raccoons captured, resulted in an estimated relative density of 7.7 raccoons/km² (Table 2). An additional 500 trap nights on a second agricultural area, in eastern Russell County, resulted in the capture of 51 unique raccoons. A density index calculation, using the study area size of 2.6 km² and the number of individual raccoons captured, resulted in an estimated relative density of 19.7 raccoons/km² (Table 2). All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Table 2. Estimated relative density indices (raccoons/ km²) of raccoon populations in Virginia, 2001-2003.

Date	Location	Habitat type	Elevation (m)	Density
July 2003	Russell County	Agricultural	530-640	7.7
July 2003	Russell County	Agricultural	700-820	19.7
November 2003	Russell County	Agricultural	700-820	12.0
July 2002	Wise County	Forested	850-1,100	4.2
August 2002	Russell County	Agricultural	530-640	6.9
July 2001	Tazewell County	Forested	730-850	4.6
July 2001	Tazewell County	Agricultural	700-800	8.1

A third relative density study was conducted in November 2003, in conjunction with the post-bait ORV surveillance trapping. This study took place on the same agricultural site as the eastern Russell County study conducted in July 2003. During November 2003, 500 trap nights resulted in the capture of 31 unique raccoons. A density index calculation, using the study area size of 2.6 km² and the number of individual raccoons captured, resulted in an estimated relative density of 12.0 raccoons/km² (Table 2).

On the western Russell County agricultural study area, trap success for unique raccoons, over 500 trap nights, was 4.0%, while overall trap success (including recaptures and non-targets) was 8.6%. On the eastern Russell County agricultural study area, trap success for unique raccoons, over 500 trap nights was 10.2% during July

2003 and 6.2% during November 2003. Overall trap success (including recaptures and non-targets) on the eastern Russell County area was 16.6% in July 2003 and 14.8% in November 2003.

Post-bait Evaluation

Approximately 3 weeks after completion of the aerial distribution of baits, WS began trapping raccoons within the baited area to collect blood and tooth samples. This post-bait ORV trapping project was conducted to collect data which will allow for evaluation of the effectiveness of the ORV program. Blood serum samples taken from raccoons within the baited area will be analyzed for the presence of virus neutralizing antibodies against rabies. Tooth samples will be analyzed for the presence of the tetracycline biomarker, which would indicate consumption of the outer portion of the bait. However, presence of tetracycline does not confirm that the vaccine sachet has been punctured or consumed. These data can be used to determine the percentage of the raccoon population, within the baited area, that ingested ORV baits and the percentage of raccoons that have an antibody titer indicative of successful vaccination.

Raccoons were live-trapped for approximately 6 weeks during October 2003-December 2003. Traps were set on private and public lands in Buchanan, Dickenson, Russell, Scott, and Wise Counties. Trapping efforts resulted in 2,286 trap nights and the capture of 110 unique raccoons (Table 3). Trap success for unique raccoons was 4.8%, while trap success for all raccoons was 5.2%. Overall trap success (inclusive of non-target captures [202] and re-captured raccoons [8]) was 13.6%.

Table 3. Post-bait ORV raccoon surveillance trapping in 5 southwest Virginia counties, October-December 2003.

County	Trap nights	Raccoons captured	Samples collected
Buchanan	258	4	4
Dickenson	688	20	20
Russell	923	53	53
Scott	363	28	28
Wise	54	5	5
Total	2,286	110	110

Non-target Captures

During the July 2003 trapping, 38 non-target animals were captured, including: 11 woodchucks (*Marmota monax*), all euthanized; 25 opossums (*Didelphis virginiana*), 3 of which were euthanized; 1 Eastern cottontail rabbit (*Sylvilagus floridanus*), released; and 1 striped skunk (*Mephitis mephitis*), released.

During the November 2003 trapping, 202 non-target animals were captured, including: 150 opossums, of which 57 were euthanized; 28 feral cats (*Felis catus*), of which 1 was found deceased in the trap and 1 was euthanized; 2 dogs (*Canis familiaris*), both released; 10 striped skunks, all released; 7 Eastern cottontail rabbits, all released; 1 bobcat (*Lynx rufus*), released; 1 common flicker (*Colaptes auratus*), released; 1 fox squirrel (*Sciurus niger*), released; 1 woodchuck, euthanized; and 1 muskrat (*Ondatra zibethicus*), released.

ORV PROGRAM 2002-EVALUATION

Serology, Tetracycline Biomarker, and Age Results

In 2002, during the Virginia, post-bait evaluation phase of the ORV program, 75 raccoons were live-trapped within the bait zone. Blood and tooth samples were collected from these animals for ORV program evaluation (Table 4 and Figure 2). Tooth samples also were collected from 29 raccoons trapped as part of 2 relative density studies, conducted in July-August 2002 (Figure 3).

SUMMARY

During the fall of 2003, approximately 390,000 ORV baits were distributed over 5,669km² in southwestern Virginia. Following the ORV bait distribution, WS trapped raccoons to collect serology and biomarker data to assess raccoon population response to ORV. In addition, in 2003 WS continued rabies enhanced surveillance activities in southwestern Virginia to further define the western border of the raccoon rabies epidemic in Virginia.

Wildlife Services also conducted relative density trapping studies to provide an index of raccoon population densities in the baited area and to collect additional serology and tetracycline biomarker data.

Oral rabies vaccination program activities in Virginia will continue in 2004. Bait will be distributed over the 2003 ORV bait zone to reinforce this ORV barrier. Wildlife Services will conduct relative density studies for population monitoring and will continue or increase enhanced surveillance efforts to monitor the movement of the raccoon strain of rabies in southwestern Virginia and to monitor the success of the ORV bait distribution program.

Table 4. Serology and tetracycline biomarker results of raccoon biological samples collected during post-bait ORV program evaluation in Virginia, 2002.

	2002
Serology	
Unique raccoons captured	75
Testable blood samples	71
Positive rabies antibody response ^a	17 (23.9%)
Tetracycline biomarker	
Unique raccoons captured	75
Testable tooth samples	72
Presence of tetracycline biomarker	18 (25.0%)

^aCenters for Disease Control and Prevention serum dilution ≥ 5

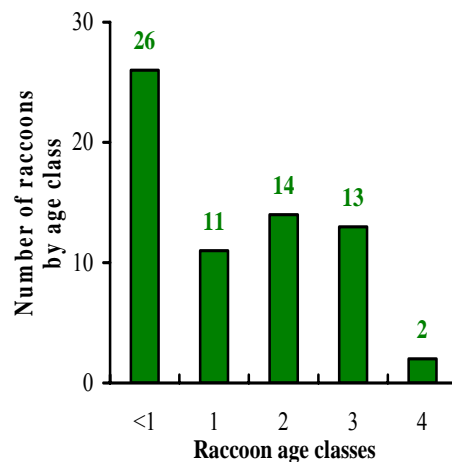


Figure 2. Age class results from 66 of 75 raccoon biological samples collected during post-bait ORV program evaluation in Virginia, 2002.

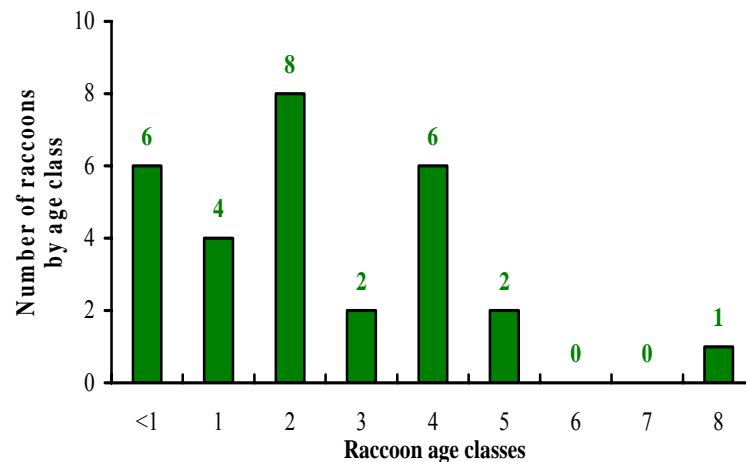


Figure 3. Age class results of 29 raccoon biological samples collected during 2 relative density studies in Virginia, 2002.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM WEST VIRGINIA 2003

BACKGROUND

The West Virginia oral rabies vaccination (ORV) program was undertaken as part of a nationwide, cooperative effort to stop the westward spread of raccoon (*Procyon lotor*) strain rabies. Raccoon strain rabies was first introduced into West Virginia in 1977, from raccoons translocated from the southern United States to Hardy County. The virus then spread along the leeward side of the Appalachian Mountains into Pennsylvania, Maryland, and Virginia until it breached the Appalachian Mountain front and began spreading in the cardinal directions through West Virginia. In 2003, 81 confirmed cases of rabies were reported in West Virginia, 50 of which were found in raccoons. Bats (order *Chiroptera*) were the second most common species with rabies in West Virginia with 13 cases confirmed in 2003. Other species included: 10 striped skunks (*Mephitis mephitis*), 6 foxes (*Urocyon cinereoargenteus* and *Vulpes vulpes*), 1 feral cat (*Felis catus*), and 1 beaver (*Castor canadensis*).

The West Virginia ORV program is being coordinated by the West Virginia Department of Agriculture (DOA), while enhanced surveillance is being conducted by the West Virginia Department of Health and Human Resources (DHHR) and county Departments of Health. Wildlife Services (WS) in West Virginia provided funding and operational support, including coordinating bait drops, enhanced surveillance, raccoon population monitoring, and assessing program progress through live trapping efforts. The West Virginia Division of Natural Resources (DNR) provided permits for handling wildlife, access to state owned property, and expertise in raccoon ecology and management.

ORV PROGRAM 2003

Bait Distribution

The 2003 ORV bait zone covered 25,356 km² (9,790 mi²) (Figure 1). During the August-October bait drop, 1,674,505 fishmeal polymer baits (FMP), containing Raboral V-RG® vaccine (MERIAL Limited, Athens, Georgia, USA), were distributed by air, while 28,018 FMP baits were distributed by hand. Aircraft and flight crew for the 2003 ORV program were provided by the Ontario Ministry of Natural Resources and Dynamic Aviation. Ground support was provided by WS personnel from West Virginia, Virginia, Tennessee, Kentucky, Ohio, and Pennsylvania, as well as the DHHR, DOA, DNR, the Ohio National Guard, and the Ohio Department of Health. West Virginia's WS program currently has 6 full-time employees working on the rabies project. Six additional employees assisted during the ORV bait drop and post-bait trapping.

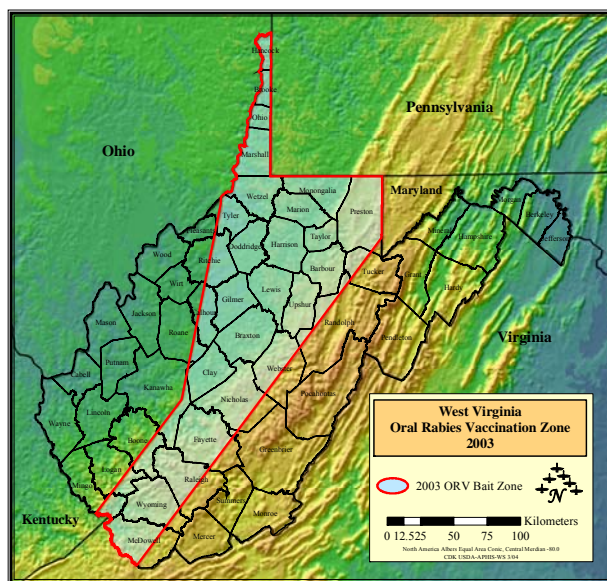


Figure 1. Oral rabies vaccination zone in West Virginia, 2003.

Surveillance

In 2002, there was a recognized need for additional enhanced surveillance throughout much of the ORV bait zone in West Virginia. In 2003, WS employed 2 new specialists to respond to sick-acting raccoon complaints and to collect brain stem samples from road-killed animals. In 2003, 10 sick acting raccoons and 138 road-killed specimens were collected by WS staff (Table 1). Of the 148 raccoons tested, 2 tested positive for rabies; 1 with bat strain rabies and the other with raccoon strain rabies.

Table 1. Brain stem samples collected, per county, by WS in West Virginia, 2003.

County	Samples collected	Number positive
Brooke	1	0
Calhoun	22	0
Doddridge	1	0
Gilmer	12	0
Grant	1	0
Kanawha	20	0
Marshall	4	1 (bat strain)
Monongalia	1	1 (raccoon strain)
Nicholas	1	0
Ohio	1	0
Pleasants	11	0
Ritchie	14	0
Roane	7	0
Taylor	3	0
Webster	1	0
Wetzel	5	0
Wirt	20	0
Wood	23	0
Total	148	2

Population Monitoring

In 2003, WS protocol for relative density population estimates was used to estimate abundance in 5 areas within West Virginia during the summer and 1 area within West Virginia during the fall. These included 3 areas previously trapped during 2001 and 2002 (Table 2). Four areas were wildlife management areas, managed by the DNR and were representative of habitat found throughout much of the state, with forested rolling hills and permanent streams. The remaining area was an agricultural site composed of forest, pasture, and corn fields. In 2003, relative density estimates were similar than those reported in 2002 (Table 2). All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Table 2. Estimated density (raccoons/km²) of raccoon populations in selected counties in West Virginia, 2001-2003.

County	Habitat	Elevation (meters)	Densities			
			2001	2002	2003 (Summer)	2003 (Fall)
Jackson	Agriculture	300	16.2	NA	NA	NA
Clay	Forested	300	8.9	6.6	7.7	NA
Wetzel	Forested	300	16.6	7.3	8.8	3.1
Braxton	Agriculture	550	13.1	6.6	NA	NA
Lewis	Forested	400	NA	7.7	NA	NA
Nicholas	Forested	550	NA	5.8	NA	NA
Barbour	Agriculture	350	NA	12.3	11.9	NA
Hardy	Agriculture	300	NA	NA	8.1	NA
Wyoming	Forested	400	NA	NA	0.8	NA
Average		383	13.7	7.72	7.46	3.1

Scent-station Surveys

In 2003, WS also began using scent-stations surveys in higher elevations (>1,067m) to determine the relative activity/density of raccoons at these elevations. Three areas were selected as scent-station sites in West Virginia, based primarily on elevation. Each of these sites ranged between 1,067 m and 1,212 m in elevation. At

each of these sites 30 scent-stations were placed along the road at 322 m intervals. Each scent-station was 0.76 meter in diameter and consisted of a mix of loose soil and sand. A shellfish oil scent tablet was placed in the middle of each station and each station was checked daily, for 5 days (Table 3). Scent-station surveys were conducted in June, July, August, and September. These data will be used in the future, along with habitat data, to determine sites for relative density population estimate studies.

Table 3. Number of individual visits, by species, recorded at scent-station survey sites conducted in 3 counties in West Virginia, 2003.

Species	Randolph County	Pendleton County	Nicholas County
White-tailed deer (<i>Odocoileus virginianus</i>)	14	25	64
Raccoon	0	7	34
Eastern cottontail rabbit	9	7	2
Fox squirrel (<i>Sciurus niger</i>)	1	7	8
Black bear (<i>Ursus americanus</i>)	0	12	14
American crow (<i>Corvus brachyrhynchos</i>)	29	1	17
Feral dog (<i>Canis Familiaris</i>)	4	3	14
Gray fox	2	14	4
Bobcat (<i>Lynx rufus</i>)	1	2	10
Coyote (<i>Canis latrans</i>)	3	0	44
Opossum	3	0	0
Turkey (<i>Meleagris gallopavo</i>)	1	1	2

Post-bait Evaluation

Following the 2003 August-October bait drop, WS live-trapped raccoons to collect blood and tooth samples to measure program success. During the months of October-November, 191 unique raccoons were trapped and biological samples collected.

Habitat Composition and Elevation Research

During 2003, WS also continued collecting habitat data to determine impacts of habitat composition and elevation on raccoon relative abundance (Table 4). A 7.97m (26.3 ft) diameter plot was sampled at each trap site, with the trap centered in each plot. Habitat characteristics are important variables that need further research, because the historical spread of rabies through West Virginia appeared to be slowed by the higher elevations of the Appalachian Mountains. Wildlife Services will continue to collect these data in 2004.

Table 4. Mean habitat characteristics, calculated at successful and unsuccessful capture sites, in West Virginia, 2002 and 2003.

Habitat characteristics	2002		2003	
	Capture	No capture	Capture	No capture
Basal area ^a	3.23	4.15	2.5	3.15
Trees >11 diameter at breast height (dbh)	2.48	2.60	2.0	1.89
Trees <11 dbh	13.10	13.37	6.47	8.35
Ground vegetation cover (%)	63.24	61.66	70.10	63.53
Canopy cover (%)	53.54	61.41	47.71	55.53
Distance (m) to water-intermittent	23.28	32.28	4.00	7.60
Distance (m) to water-permanent	38.13	53.51	53.66	27
% slope	8.16	10.77	9.26	7.69
Elevation (meters)	1,251	1,242	1,003	860
Den sites	0.30	0.06	0.70	0.16
Tree/shrub species				
Red oak (<i>Quercus rubra</i>)	2.17 ^b	2.27	2.20	1.92
White oak (<i>Quercus alba</i>)	2.06	2.54	3.89	1.61
Beech (<i>Fagus grandifolia</i>)	2.92	2.04	2.0	2.10
Hickory (<i>Carya spp.</i>)	1.67	2.25	2.00	3.33
Black walnut (<i>Juglans nigra</i>)	1.54	1.54	2.00	1.5
Common apple (<i>Malus sylvestris</i>)	7.4	1.94	1.40	1.38
Pear (<i>Pyrus communis</i>)	1.00	1.00	0.00	3.00
Black cherry (<i>Prunus serotina</i>)	2.73	2.77	2.00	2.24
Flowering dogwood (<i>Cornus florida</i>)	1.00	2.06	0.00	0.00
Blackberry (<i>Rubus spp.</i>)	4.62	6.50	1.00	4.46
Grape (<i>Vitis spp.</i>)	2.44	2.24	5.64	2.45
Autumn olive (<i>Elaeagnus umbellata</i>)	2.82	3.76	3.89	4.90

^acalculated using a 20-factor prism; ^btree/shrub species per plot

Non-target Captures

Non-target species captured and released unharmed included: 75 opossum (*Didelphis virginiana*), 2 beaver, 8 striped skunks, 9 Eastern cottontail rabbits (*Sylvilagus floridanus*), and 5 woodchucks (*Marmota monax*). Non-target species captured and euthanized included 1 striped skunk.

ORV PROGRAM 2002-EVALUATION

Serology, Tetracycline Biomarker, and Age Results

In 2002, 70 raccoons were trapped as part of the post-bait ORV evaluation. Blood and tooth samples were collected from these animals for ORV program evaluation (Table 5). Tetracycline biomarker and age results are not yet available.

Table 5. Serology results of raccoon biological samples collected during post-bait ORV program evaluation in West Virginia, 2002.

	2002
Serology	
Unique raccoons captured	70
Testable blood samples	70
Positive rabies antibody response ^a	23 (32.9%)

^aCenters for Disease Control and Prevention serum dilution ≥ 5

SUMMARY

In 2001, West Virginia became involved in the nationwide ORV program as a key state in establishing a national barrier to prevent the westward spread of raccoon strain rabies. During the bait drop, which began on 18 August 2003, 1,674,505 FMP baits were distributed by air and 28,018 FMP baits were distributed by hand. Post-bait ORV monitoring results from 2002 revealed that 23 (32.9%) of 70 raccoons captured had a positive rabies antibody titer.

The 2004 bait zone in West Virginia will remain the same. Also during 2004, West Virginia WS will continue to investigate the influence of elevation and habitat by collecting pertinent habitat data at each trap location, as well as, determining relative population density estimates at sites $>1,067$ meters in elevation. Enhanced surveillance and trapping efforts will continue to be expanded during pre- and post-bait ORV monitoring to increase sample size.

WILDLIFE SERVICES COOPERATIVE RABIES MANAGEMENT PROGRAM WYOMING 2003

BACKGROUND

Historically, Wildlife Services (WS) has not played a significant role in rabies control and surveillance in Wyoming due to lack of funding and constraints of our cooperative agreements, to provide services to individual county predatory animal boards. A majority of our cooperative services have been directed toward the management of predators, primarily coyotes (*Canis latrans*), to protect sheep (*Ovis aries*) and cattle (*Bos Taurus*).

In 2003 and early 2004, we completed 1 of 2 oral rabies vaccination (ORV) rabies placebo bait projects. The objective of these projects is to determine which bait would be best suited ORV targeting striped skunks (*Mephitis mephitis*) in Wyoming and other western states.

In 2003, WS completed a statewide wildlife rabies coordination plan, in partnership with the Wyoming Animal Damage Management Board (ADMB). Significant progress also was made in planning a rabies surveillance program throughout the state by WS personnel, which will begin in early 2004.

ORV PROGRAM 2003

Skunk Oral Rabies Placebo Bait Study

In August 2003, WS participated in a multi-state study (Wyoming, Arizona, Texas, Louisiana, and California), coordinated by the WS, National Wildlife Research Center (NWRC), Ft. Collins, Colorado, to test ORV bait acceptance by skunks in Weston County (Figure 1). Also in 2003, preparations were made to conduct 1 study in Big Horn County, November 2004.

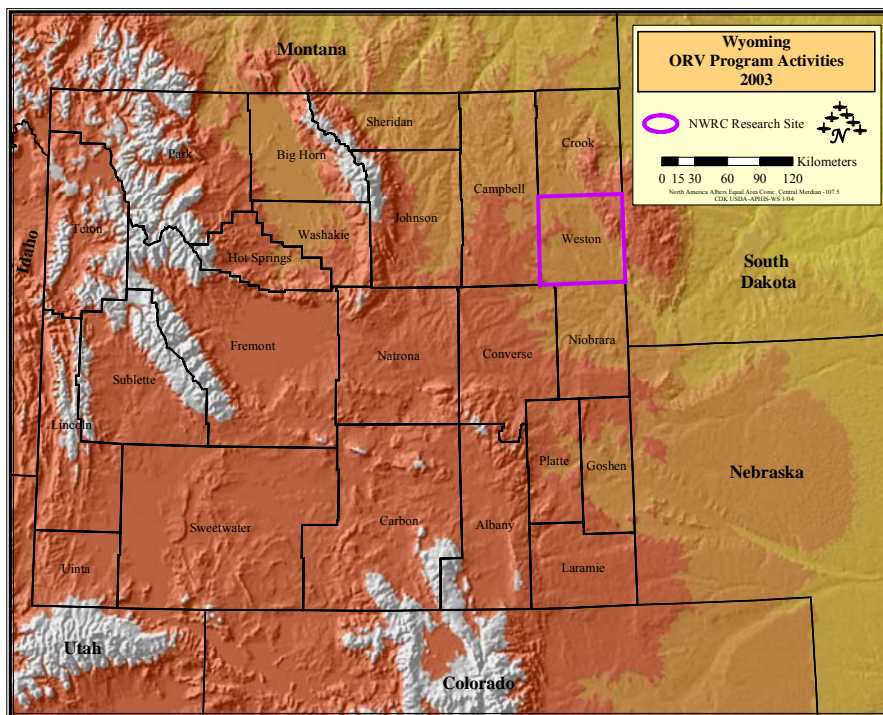


Figure 1. Oral rabies vaccination program activities in Wyoming, 2003.

On 7 June 2003, baits were placed by horseback on the 2 study areas in Weston County. Each study area was 4 km x 10 km in dimension and baits were placed every 7.5 meters along 3 transect lines, which were oriented lengthways in the study areas. Artemis Ontario Slim baits (Artemis Technologies, Inc., Guelph, Ontario, Canada) were distributed in the Upton study area and Merial Cylindrical baits (MERIAL Limited, Athens, Georgia, USA) were distributed in the Buffalo Creek study area.

Trapping took place on the 2 study areas with Tru-Catch live traps (Manufacturing Systems, Inc., Belle Fourche, SD, USA) baited with sardines in oil on 4-15 August. Traps were placed at suitable locations along the 3 transect lines at a rate of 1 trap every 0.5 km, for a total of 57 live traps in each of the 2 study areas. At the conclusion of trapping, 52 striped skunks, 104 raccoons (*Procyon lotor*), 20 feral cats (*Felis cattus*), and 2 red foxes (*Vulpes vulpes*) were captured and euthanized. Biological data collected from each animal was sent to NWRC for analysis and included: jaws, for tetracycline biomarker presence; blood serum, for rabies titer testing; and DNA samples. All heads were sent to the Wyoming State Veterinary Laboratory for rabies testing. All animals trapped in 2003 were handled according to the American Veterinary Medical Association guidelines.

Skunk Oral Rabies Placebo Bait Study-Evaluation

None of the animals captured on the Upton or Buffalo Creek study areas tested positive for rabies. On the Upton study area, 1 (3.1%) skunk (juvenile female) and 2 (66.6%) raccoons tested positive for tetracycline biomarker. On the Buffalo Creek study area, 3 (15.0%) skunks (1 adult male, 2 juvenile females) and 7 (41.2%) raccoons tested positive for tetracycline biomarker.

Other Rabies Activities

In 2003, WS continued to participate in rabies surveillance and monitoring work in Campbell County, as part of normal work activities conducted by a WS Specialists stationed there. Also, the Wyoming ADMB provided the Wyoming State Veterinary Laboratory funding to test all heads submitted by WS personnel throughout the state, as part of a scheduled rabies surveillance program that will be implemented on the ground in spring 2004. This funding also will be used to purchase specimen shipping containers, postage, and any miscellaneous costs that might be incurred, such as testing results notification and rabies strain typing, if warranted. This surveillance will be conducted throughout the state in counties that currently cooperate with WS as part of the Specialists duties. If time and circumstances permit, this surveillance also will be conducted in non-WS cooperating counties.

SUMMARY

In 2003, WS rabies activities were focused on the initiation and development of cooperative working agreements with local, state, and federal agencies. An ORV placebo bait study was completed in Weston County. Equipment such as vehicles and live traps were purchased for work to be completed in upcoming surveillance trapping efforts. Significant progress has been made in training WS personnel and in starting to establish groundwork for future rabies work.

Cooperative Agreements.--

Pennsylvania State University, Wildlife and Fisheries Science Program – Zoogeography of common raccoons in Western Pennsylvania.

Texas A&M University Kingsville, Caesar Kleberg Wildlife Research Institute – Ecology of urban skunks in Texas.

Northern Arizona University, Biological Sciences Department –
Home range, movements and denning characteristics of skunks in Flagstaff.

Objective 2

Develop methods that decrease transmission of rabies among wildlife, livestock, and humans.

A study conducted in collaboration with Pennsylvania Wildlife Services (WS) to determine the most effective bait density for delivering ORV to raccoons (*Procyon lotor*) is nearing completion. This study evaluated four bait density treatments (37, 75, 150, and 300 baits/km²). Treatment areas consisted of 582.7 km² (225 mi²) zones in northwestern Pennsylvania (Figure 1). Preliminary data indicated that doubling the bait density resulted in about a 25% increase in raccoons positive for biomarker. This study will provide the ORV program with critical data on the most efficient baiting strategy for raccoons.

Scientists at the NWRC Sandusky Field Station have completed a study to determine the fate of ORV baits in the environment (Figure 1). Currently, they are collaborating with Ohio State University (OSU) to quantify the effectiveness of ORV bait distribution relative to raccoon population density and bait distribution density. The objectives of the study are to: (1) estimate the density of the raccoon population on the National Aeronautics and Space Administration (NASA) Plum Brook Station, using two separate and independent methods (Line transect surveys, using a Forward-looking Infrared Camera and mark-recapture); (2) determine population characteristics, including age and sex ratios, along with population turnover; (3) estimate bait uptake and encounter rates; (4) estimate the sero-prevalence of rabies-neutralizing antibodies before and up to one year after the 2003 bait distribution (at 75 baits/km²); and (5) model population density and turnover, along with sero-prevalence, to make recommendations for timing, density, and frequency of bait distribution. Factors such as population turnover via mortality, recruitment, emigration, and immigration directly affect the proportion of immune animals. Further, quantifying population-level effects is contingent upon detecting immune animals over time. Understanding the size of the immune class within a target population is critical to maintenance of ORV barriers and projection of ORV program costs. This work is being conducted by a graduate student with the OSU School of Natural Resources and will continue through October 2004.

A multi-state study has been initiated to evaluate potential rabies baits for use in future ORV activities. Currently, no acceptable bait for distribution of a rabies vaccine has been developed. This study is being conducted in Texas, California, Arizona, Wyoming, and Louisiana (Figure 1). The study is evaluating the potential for the Artemis Ontario Slim and Merial Cylindrical baits (Merial, Athens, Georgia, USA) for potential use in ORV programs for skunks.

We are also developing and evaluating ORV baits for skunks at the NWRC Outdoor Animal Research Facility, Ft. Collins, CO (Figure 1). There is limited literature on skunks as non-target consumers of ORV-laden baits. That skunks will chew on baits intended for other species indicates the potential exists for baiting skunks with ORV in the field. On the other hand, flavor-coated sachet baits (sachets directly coated with flavoring versus the typical fish meal polymer baits with uncoated sachets inside), used for vaccinating raccoons and coyotes (*Canis latrans*) in Texas, Georgia, and Ohio, did not appear to be consumed by skunks. Overall, low or no uptake of baits by skunks suggests that current baits are ineffective for skunks. Skunks either find baits unpalatable or had physical difficulties in handling the baits. We intend to observe the manipulation by skunks of baits to assist in formulation and development of an ORV-laden bait that will enhance their uptake. We are using a liquid biomarker within sachets as a mock vaccine to quantify the liquid uptake that is likely after a skunk encounters ORV bait. This information would be useful (1) for determining whether or not the sachet, in its current stage of development, facilitates dosage-by-puncture, and (2) in determination of the number of baits to be distributed over a particular area in ORV-bait delivery projects (based on milliliters of vaccine required/skunk and expected uptake in milliliters/skunk).

Additional studies are being conducted to evaluate biomarkers in ORV baits. The Wildlife Services Management Team has identified a need for evaluation of the current tetracycline biomarker in ORV baits, and the

development of alternative biomarkers. We have initiated research to evaluate the quality control of the tetracycline biomarker in ORV baits, the potential for mixing the tetracycline biomarker in the vaccine sachet, and the potential for using alternative biomarkers (e.g., fatty acid and stable isotopes).

Study Protocols.--

QA-983 Comparison of bait consumption and vaccination rates of raccoons exposed to 3 densities of Raboral V-RG® rabies vaccine.

QA-965 Fate of oral rabies vaccine bait relative to raccoon density.

QA-998 Efficacy of oral rabies vaccination relative to bait density and raccoon population density.

QA-1034 Development of Fatty Acid, Stable Isotope & Molecular Genetic Biomarkers For Determining Consumption of Vaccine Baits by Wildlife.

QA-1040 Acceptance of placebo rabies baits by skunks.

QA-1044 Manipulation and uptake by skunks of baits intended for use in large-scale ORV.

QA-1068 Efficacy of Mixed Rabies Vaccine -Tetracycline Biomarker.

Cooperative Agreements.--

Ohio State University, School of Natural Resources - Efficacy of oral rabies vaccination relative to bait density and raccoon population density.

Objective 3

Develop a method to evaluate the effectiveness of management practices on reducing the prevalence of rabies in wildlife.

Evaluating the effectiveness of ORV treatments currently depends on estimating the percentage of the target population that is positive for biomarker. Unfortunately, this method has limitations that minimize its effectiveness. Additionally, delivering the most effective density of ORV baits to target populations requires an accurate estimation of population density. Currently, our ability to estimate densities of raccoon and skunk populations is extremely limited. The potential use of hair or feces for genetic analyses presents the opportunity to monitor wildlife species in for a variety reasons. By including a hair removal device at a bait station, genetic analyses could allow the identification of which species, sexes, or individuals are removing the baits. Genetic analyses of hair at bait stations will allow estimations of the proportion of baits removed by the target species, any sex biases in removal, as well as the ability to enumerate how many individuals are involved in bait removal. We have initiated a study to determine if genetic markers would be useful in determining rabies vaccination rates and to estimate densities of target populations of skunks and raccoons.

A cost-savings model of oral vaccination for raccoon-variant rabies was developed. This model considers that pre-epizootic medical, veterinary, legal, and insurance costs are produced by the combined effects of bat-, fox-, coyote-, raccoon-, and skunk-variant rabies. During a rabies outbreak, these costs “spike.” The local or regional savings offered by an ORV Program is the relative difference between baseline and epizootic costs, minus those charges linked with ORV. This cost difference between pre-epizootic and epizootic rabies for total pet vaccinations, livestock vaccinations, pet replacements, livestock replacements, suspected rabid-animal quarantines, public health activities, human pre-exposure vaccinations, human post-exposure treatments, and human deaths form the maximum savings that can result from ORV. Several studies to estimate costs of specific elements in the model are underway (e.g., quarantine charges and human post-exposure prophylaxis treatments).

Excel XP® (Microsoft Corporation, Redmond, WA, USA) code was prepared to compute potential net savings and benefit-cost ratios associated with Raboral V-RG® bait distributions for raccoon-variant rabies. Iterative runs of the code allowed plotting saving and ratio response surfaces for diverse scenarios based on 6 ORV

variables [i.e., area (km²), bait-price, bait-density (#/km²), application frequency, mode-of-delivery [% fixed-winged, % rotary-winged, and % ground-dispensed, and effectiveness (% seropositive titer conversion)].

In September 2002, a Cooperative Agreement was set up between The California Department of Public Health and the Animal and Plant Health Inspection Service for research of direct and indirect benefit-cost effects linked to skunk rabies in that state. These data will quantify direct and indirect costs of post-exposure rabies prophylaxis (PEP), public health, and animal control expenses linked to rabies in Santa Barbara and San Luis Obispo Counties, California. Interviews of 55 patients treated for rabies exposure were completed; this represented 50% (110 hospital PEPs) of cases in the 2 counties (30 Santa Barbara/80 San Luis Obispo) since 1996. Skunk rabies cases were low-only 4 interviews of these patients were present in the dataset. The breakdown of interviews by rabid animal was: 19 bats, 8 cats of identified owner, 12 dogs of identified owner, 3 foxed, 4 skunks, and 9 other species).

Study Protocols.--

QA-802 Spreadsheet development to estimate economic indices of wildlife damage intervention (QA-802).

QA-816 Post-exposure prophylaxis cost analysis of skunk rabies cases in Santa Barbara and San Luis Obispo Counties, California.

QA-1034 Development of Fatty Acid, Stable Isotope, and Molecular Genetic Biomarkers For Determining Consumption of Vaccine Baits by Wildlife.

Publications

Blackwell, B. F., T. W. Seamans, R. J. White, Z. J. Patton, R. M. Bush, and J. D. Cepek. In Review. Efficacy of oral rabies vaccine baiting density relative to raccoon population density. *Journal of Wildlife Diseases*.

Sterner, R. T., M. M. Kling, S. A. Shwiff, and D. Slate. Oral rabies vaccination: Reducing economic uncertainty via response surface analysis. *Proceedings Wildlife Damage Management Conference 10*:in press.

Presentations

DeLiberto, TJ. 2003. Acceptance and Vaccination Rates of Raboral V-RG ® by Raccoons In Three Bait Density Zones. USDA/APHIS/WS Rabies Management Team Meeting, Fort Collins, CO.

DeLiberto, TJ. 2003. Acceptance of Placebo rabies baits by Skunks. USDA/APHIS/WS Rabies Management Team Meeting, Fort Collins, CO.

DeLiberto, TJ. 2002. Research in support of the United States Department of Agriculture's Rabies Control Program. Nebraska Rabies Task Force. Lincoln, NE.

DeLiberto, TJ. 2002. Acceptance and Vaccination Rates of Raboral V-RG ® by Raccoons In Three Bait Density Zones. USDA/APHIS/WS Rabies Biologist Meeting, Raleigh, NC.

DeLiberto, TJ. 2002. Acceptance of Placebo rabies baits by Skunks. USDA/APHIS/WS Rabies Biologist Meeting, Raleigh, NC.

DeLiberto, TJ, and Slate, D. 2002. Research in support of the United States Department of Agriculture's Rabies Control Program. XIII International Meeting of Rabies in the Americas, Oaxaca City, Mexico.

Sterner, R. T., S. A. Shwiff, and D. Slate. 2003. A cost-savings model of wildlife rabies and oral vaccination. 4th European Pest Conference, Parma, Italy.

Sterner, R. T., S. A. Shwiff, M. M. Kling, and D. Slate. 2003. Wildlife rabies: Modeling the economic impacts. 10th Annual Conference of The Wildlife Society, Burlington, VT.

- Sterner, R. T., S. A. Shwiff, M. A. Kling, and D. Slate. 2003. Oral Rabies Vaccination: Reducing economic uncertainty via response surface analysis. 10th Wildlife Damage Management Conference, Hot Springs, Arkansas.
- Sterner, R. T., and S. A. Shwiff. 2002. Economic methods and issues in wildlife disease research. Pages 22-23 *in* Minutes of Western Coordinating Committee-95, Vertebrate Pests of Agriculture, Forestry, and Public Lands, Reno, NV.